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SM2A-07-BP15

NASA
SUPPORT MANUAL

APOLLO
DESCRIPTION MANUAL
FOR
BOILERPLATE 15

[redacted]

CONTRACT NAS 9-150
EXHIBIT I; PARAGRAPH 10.3

THIS MANUAL REPLACES SM2A-07-BP15 DATED 30 NOVEMBER 1963

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INTRODUCTION

This manual pertains to the mission, and provides physical and operational descriptions of boilerplate 15, part No. B14-000002-201, manufactured by Space and Information Systems Division of North American Aviation, Inc., Downey, California. Supporting documentation and ground support equipment is described in general terms. Functional schematics and block diagrams are also included in this manual. The applicability of this manual is listed in the Index of Apollo Support Manuals and Procedures, SM1A-1.

SECTION I

MISSION AND OBJECTIVES

1-1. PURPOSE.

1-2. This section describes the mission and objectives of boilerplate 15 (figure 1-1). A mission profile is shown in figure 1-2.

1-3. BOILERPLATE 15 MISSION.

1-4. The mission prescribed for boilerplate 15 is the second in a series to develop and qualify compatibility of the Apollo spacecraft with the Saturn I launch vehicle and to define the launch and exit environmental parameters. The spacecraft will be launched by a Saturn I booster from the Atlantic Missile Range (AMR) at a launch azimuth of 90 degrees from true north. A flight azimuth of 105 degrees will be obtained soon after launch by a programed roll maneuver.

1-5. FIRST ORDER TEST OBJECTIVES.

1-6. First order test objectives of the boilerplate 15 flight test are as follows:

a. Demonstrate the physical compatibility of the launch vehicle and spacecraft under preflight and flight conditions.

b. Determine the launch and exit environmental parameters to verify design criteria.

c. Demonstrate the alternate mode of launch escape tower jettison, using the launch escape and pitch control motors.

1-7. SECOND ORDER TEST OBJECTIVES.

1-8. Second order test objectives of the boilerplate 15 flight test are as follows:

a. Demonstrate the structural integrity of the launch escape system under flight-loading conditions.

b. Demonstrate the compatibility of the R&D communications and instrumentation systems with the launch vehicle systems.

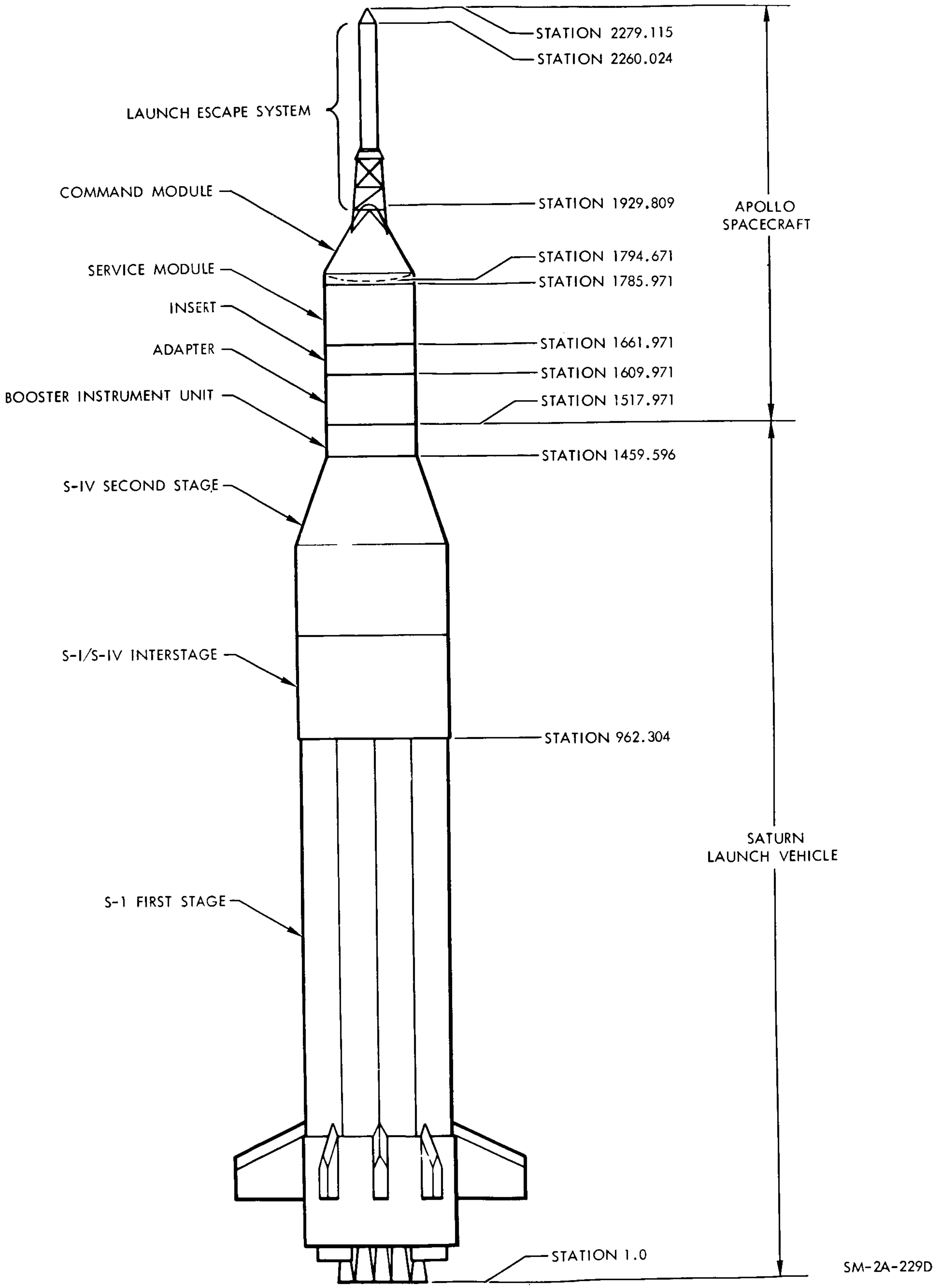
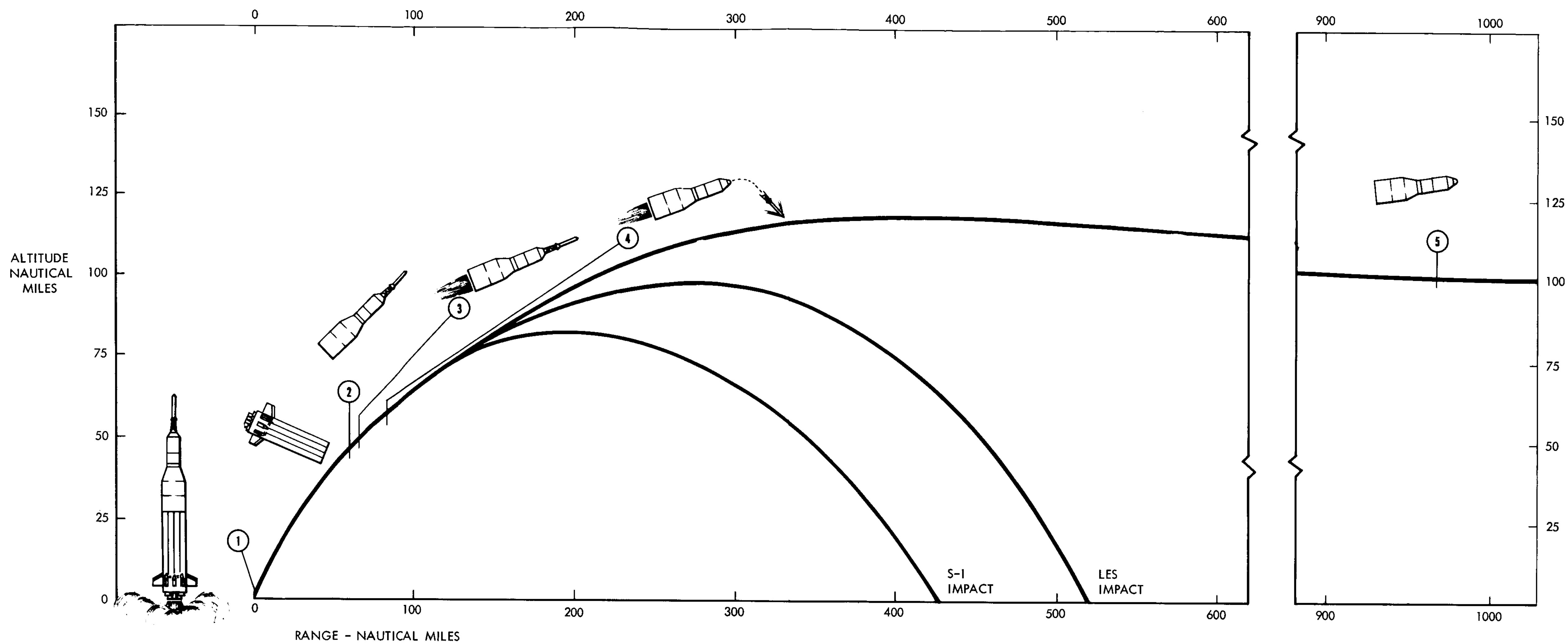


Figure 1-1. Booster Compatibility Space Vehicle



SEQUENCE OF MAJOR EVENTS

1 LAUNCH (LIFT-OFF):
2 S-I BURNOUT AND SEPARATION
3 S-IV IGNITION
4 LES JETTISON
5 S-IV BURNOUT AND ORBIT INJECTION

SM-2A-307C

Figure 1-2. Flight Sequence and Trajectory

SECTION II

PHYSICAL DESCRIPTION

2-1. PURPOSE.

2-2. This section contains a physical description of the launch escape system, command module, service module, insert, and adapter. The boilerplate 15 spacecraft, mounted on a Saturn I launch vehicle, comprises the complete test vehicle. (See figure 1-1.)

2-3. LAUNCH ESCAPE ASSEMBLY.

2-4. Structural relationships and physical location of the components of the assembly are shown in figure 2-1. Pertinent physical characteristics are contained in table 2-1.

Table 2-1. Launch Escape Assembly Physical Characteristics

Overall Dimensions:	
Length	33 feet
Weight	6600 pounds
Tower Structure:	
Length	118 inches
Width (top of tower)	36 inches
Width (bottom of tower)	50.6 inches
Weight	533 pounds
Structural Skirt:	
Length	18.25 inches
Diameter	48.8 inches
Weight	227 pounds (approx)
Launch Escape Motor:	
Length	185.3 inches
Diameter at nozzle exit	28 inches
Diameter of motor structure	26 inches
Weight	4767 pounds (approx)
Tower Jettison Motor:	
Length	55.6 inches
Diameter at nozzle exit	28 inches
Diameter of motor structure	26 inches
Weight	529 pounds (approx)

Table 2-1. Launch Escape Assembly Physical Characteristics (Cont)

Pitch Control Motor Structure:	
Length (includes ballast and motor structure)	18.62 inches
Diameter	26 inches
Weight	158 pounds (approx)
Pitch Control Motor:	
Length	22 inches
Diameter of body	8.79 inches
Diameter of flange	10.51 inches
Weight	47 pounds (approx)
Ballast:	
Diameter of lead discs	20.5 inches
Thickness	1.13 inches
Weight	189 pounds (approx)
Ballast Enclosure:	
Length	29 inches
Diameter (forward end)	13.1 inches
Diameter (aft end)	26 inches
Weight	73 pounds (approx)
Nose Cone (Q-Ball):	
Length	19.09 inches
Diameter (forward end)	2 inches
Diameter (aft end)	13.03 inches
Weight	35.1 pounds (approx)

2-5. STRUCTURE.

2-6. A truss-type tower structure is the base of the launch escape assembly. The tower is an open frame of welded titanium tubing covered with silica-filled Buna-N rubber for insulation. Each of the four legs is attached to the command module by an explosive bolt (figure 2-2). Attachments at the top of each tower leg facilitate tower alignment (figure 2-3). A structural skirt is attached between the top of the tower structure and the base of the launch escape motor. The housing of the launch escape motor forms a structure between the structural skirt and the interstage structure. The interstage structure (figure 2-4) is a welded cylindrical structure which houses the tower jettison motor exhaust nozzles and various electrical components. Two access doors facilitate installation and removal of the components. The housing of the tower jettison motor and the pitch control motor form a structure between the interstage structure and the ballast housing. The ballast housing (figure 2-5) and the nose cone (MSFC-furnished Q-ball) are of welded Inconel sheet construction, and are bolted together to form a single conical structure to house the sheet lead ballast, sensors, and electronic modules installed in the nose cone (Q-ball).

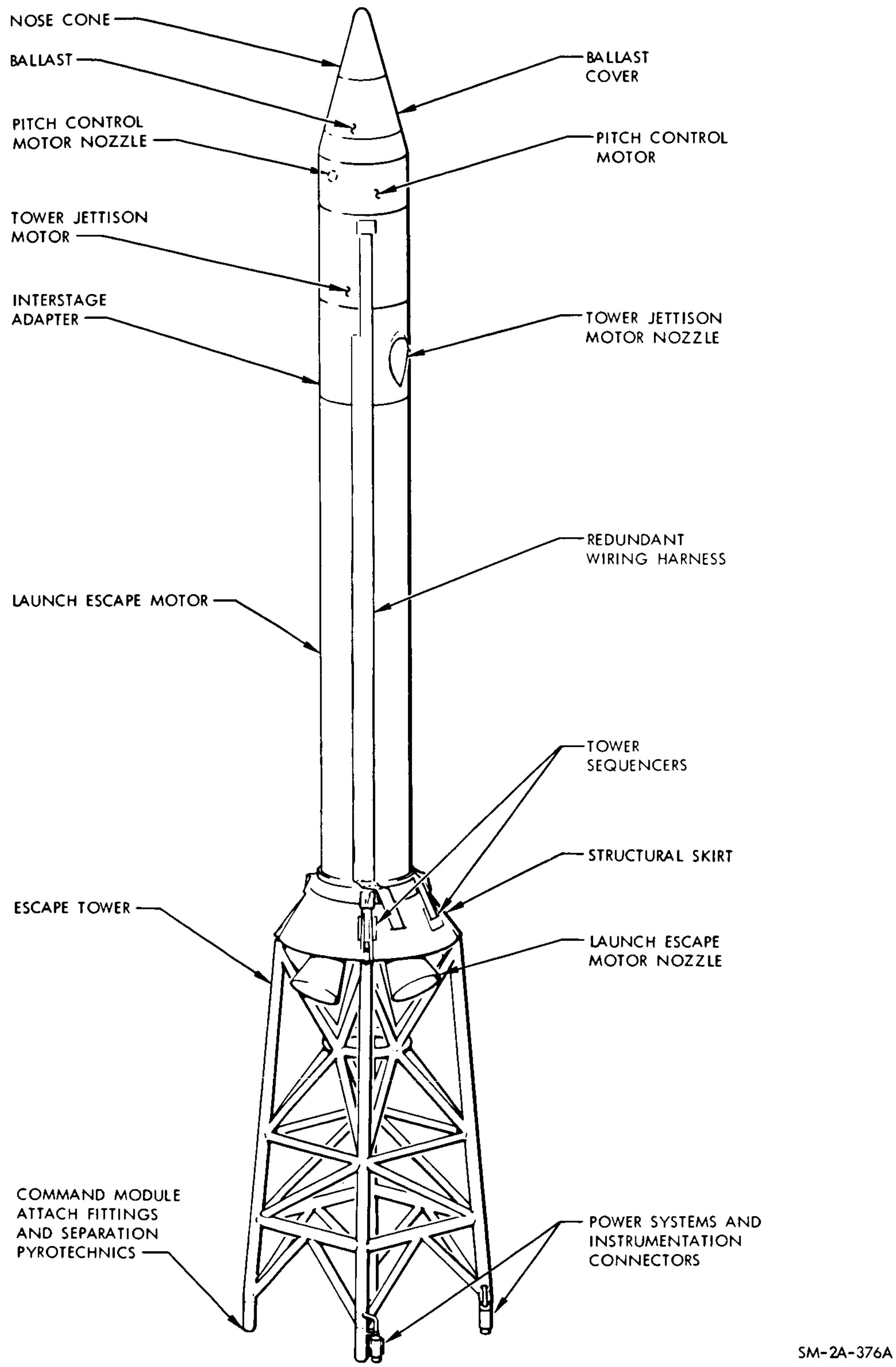


Figure 2-1. Launch Escape Assembly

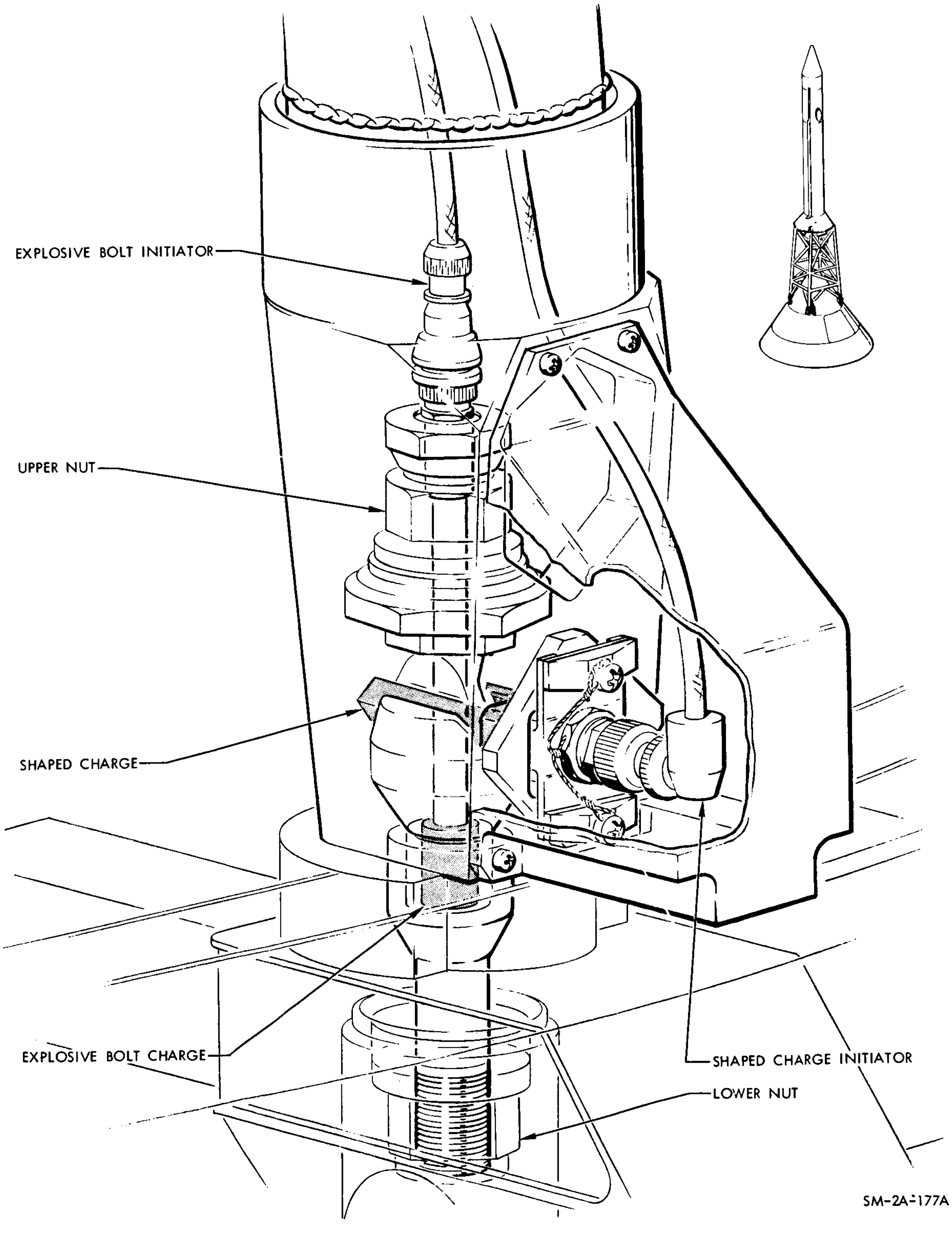


Figure 2-2. Escape Tower Explosive Bolt

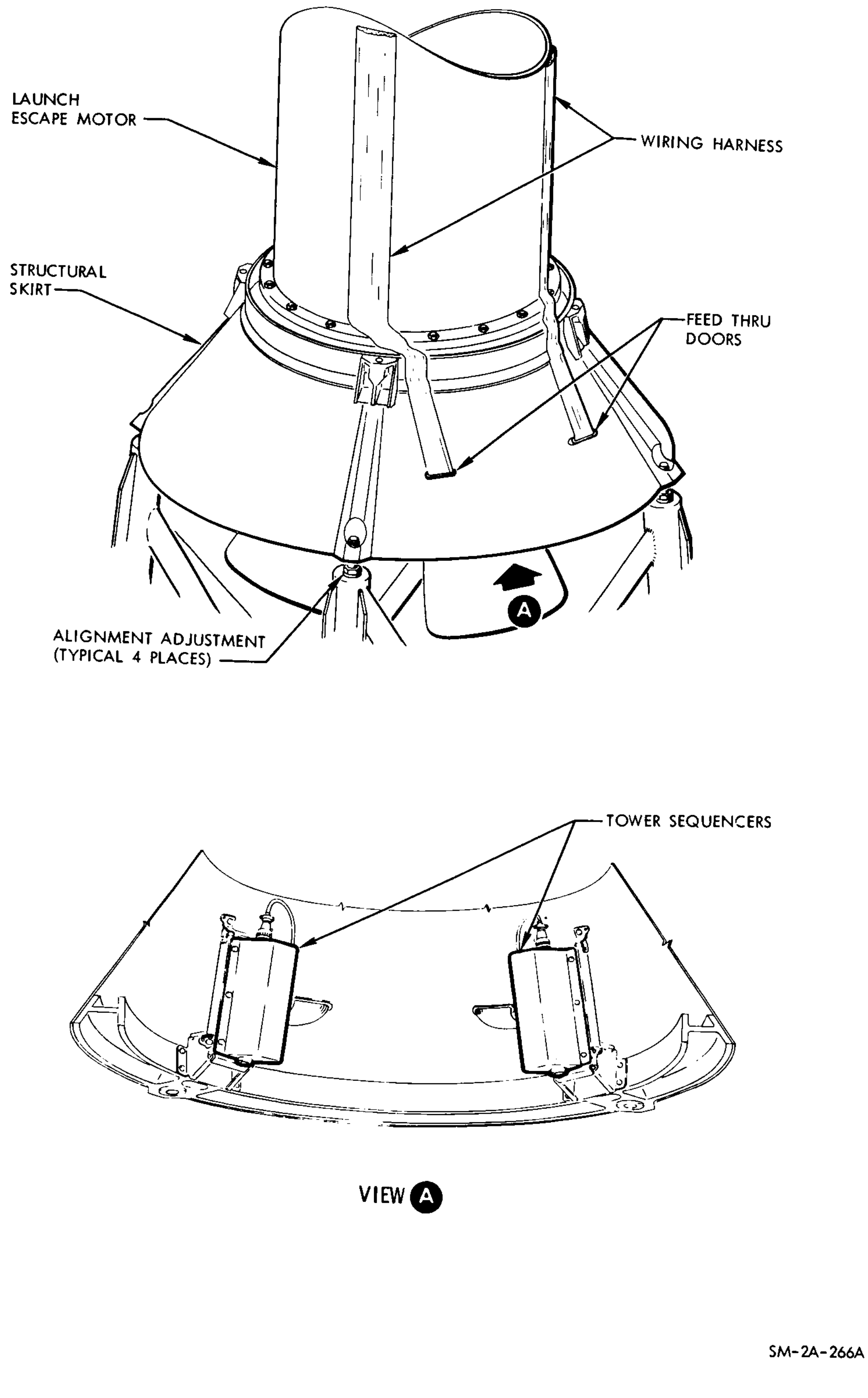


Figure 2-3. Launch Escape Motor and Structural Skirt Area

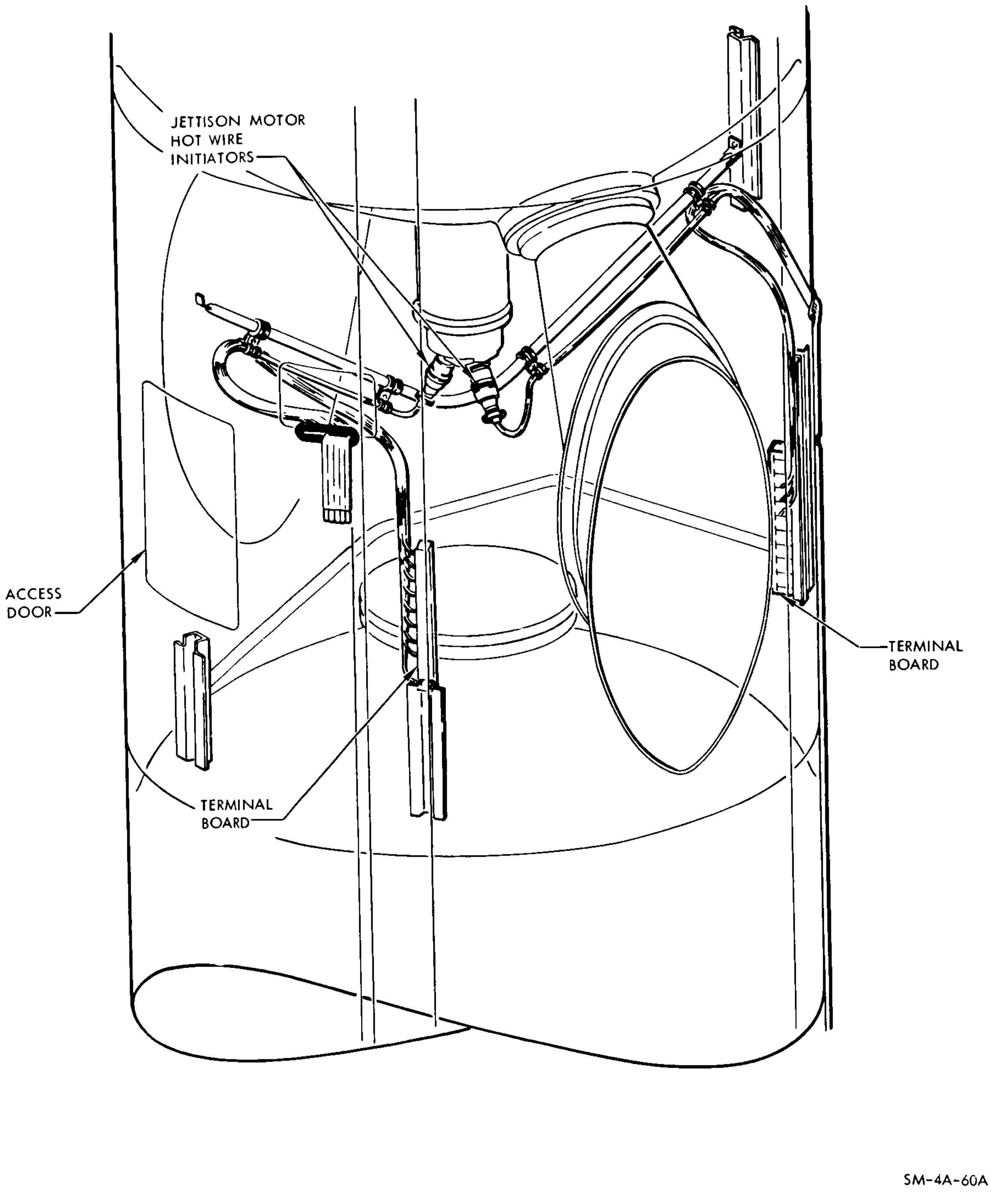


Figure 2-4. LES Interstage Adapter Area Components

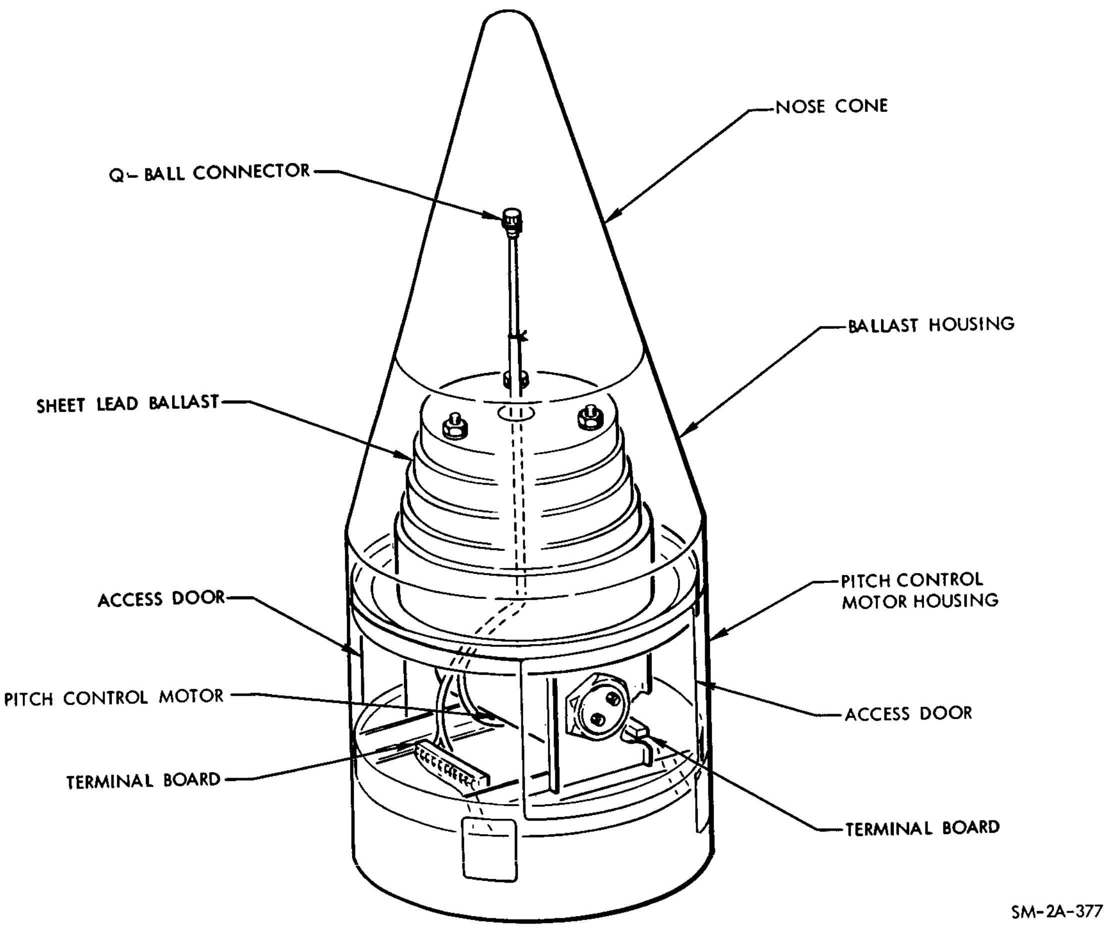


Figure 2-5. Nose Cone and Pitch Control Motor Area

2-7. MOTORS.

2-8. Three launch escape assembly motors are stacked above the tower structure. The pitch control motor is located just under the ballast with the motor nozzle extending outward on a horizontal plane through the pitch control motor housing. Two doors, approximately 180 degrees apart, permit access to the hot wire initiators and associated wiring. The jettison motor (figure 2-4) is located just below the pitch control motor. Two fixed nozzles extend downward through the interstage area, canted to exit through the structure housing just above the launch escape motor fuel tank. Two doors permit access to hot wire initiators and associated wiring in the jettison motor and interstage adapter areas. The launch escape motor housing extends from the jettison motor nozzles to interface with the structural skirt. (See figure 2-3.) The four launch escape motor nozzles are canted to thrust away from the command module. Igniters are located under the structural skirt.

2-9. ELECTRICAL AND ELECTRONIC COMPONENTS.

2-10. The electrical and electronic components in the launch escape assembly consist of launch escape sequencers, hot wire initiators, and associated wiring harnesses and attachments. Two logic and two pyro batteries, located in the command module, supply power to operate the launch escape assembly. Redundant wiring harnesses, bonded to the exterior of the launch escape motor, and associated redundant harnesses are integral to the tower structure. Each tower structure harness has a breakaway plug that allows the harness to detach from the command module when the launch escape tower is jettisoned. The wiring harnesses provide means for connecting the rocket motor and separation circuits with the sequence controllers, and the instrumentation components with the communications equipment.

2-11. SEQUENCERS.

2-12. Three sequencers are provided to program the sequence of events during the mission. Two tower sequencers (figure 2-3), located on the structural skirt, are identical in size and shape. Each tower sequencer is approximately 2.5 inches in width, 8.25 inches deep, and 3.75 inches high. A mission sequencer is installed in the command module and is a single-enclosed assembly approximately 15 inches wide, 8.25 inches deep, and 7 inches high.

2-13. HOT WIRE INITIATORS.

2-14. The two hot wire initiators (figure 2-4) for the tower jettison motor are threaded plug devices. Both initiators contain the electrical circuitry and explosives necessary to detonate the motor igniters. The initiator body is 1 inch long with a 0.75-inch flange, 0.45 inch from the threaded end. Threads are located on one end and an electrical connector at the other end. The electrical connector contains four pins to supply power to two independent bridgewire circuits.

2-15. UMBILICAL CONNECTORS.

2-16. Two electrical umbilical connectors join the electrical systems of the launch escape assembly and the command module. These connectors are located on the plane-of-separation adjacent to the escape tower leg wells of the forward heat shield of the command module. The receptacle portion of the connector is attached to the command module structure. The plug is attached to the nearest tower leg by a lanyard. When the escape tower separates from the command module, the lanyard pulls the plug from the receptacle. The plugs are part of the launch escape tower wiring installation and separate with the tower. The receptacles are part of the command module wiring installation and remain with the command module.

2-17. <u>COMMAND MODULE.</u> (See figures 2-6 and 2-7.)

2-18. The boilerplate command module simulates the production command module in external size and shape. Physical characteristics for the command module are listed in table 2-2. The reference axes are shown in figure 2-8.

Table 2-2. Command Module Physical Characteristics

Shape	Conical
Height	134 inches
Diameter	154 inches
Weight	9262 pounds

2-19. STRUCTURE.

2-20. The command module structure is conical with a convex base and a rounded apex. The sides are semimonocoque aluminum structures and terminate in the forward and aft heat shields. The command module is covered with a cork material to protect the aluminum structure against aerodynamic heating. A main hatch in the side of the primary structure permits access to the interior. Shelves and brackets along the inner wall afford mounting provisions for equipment. Compartmentation is described in table 2-3.

Table 2-3. Command Module Compartmentation

Compartment	Production Configuration Function	Boilerplate 15 Contents
Primary structure	Crew compartment.	Launch escape tower sequencer, R&D communications and instrumentation, ballast to simulate weight and center of gravity, egress tube to simulate production tube volume and main hatch, and R&D cooling system.
Forward compartment	Houses parachute system of ELS, reaction thrust jets, and associated equipment.	Radome and telemetry antenna.
Aft compartment	Houses dummy shock struts, environmental control system storage facilities, and C/M to S/M umbilicals.	Aft heat shield attachment fittings, GSE attach fittings, umbilical connectors, equipment access doors, service module mating bearing pads, and tension ties.

2-21. FORWARD HEAT SHIELD.

2-22. The forward heat shield forms the apex of the command module. It consists of a sheet metal cover and a fiberglass honeycomb radome assembled together with the assembly bolted to the command module. There are no provisions for separating the forward heat shield, since recovery is not planned.

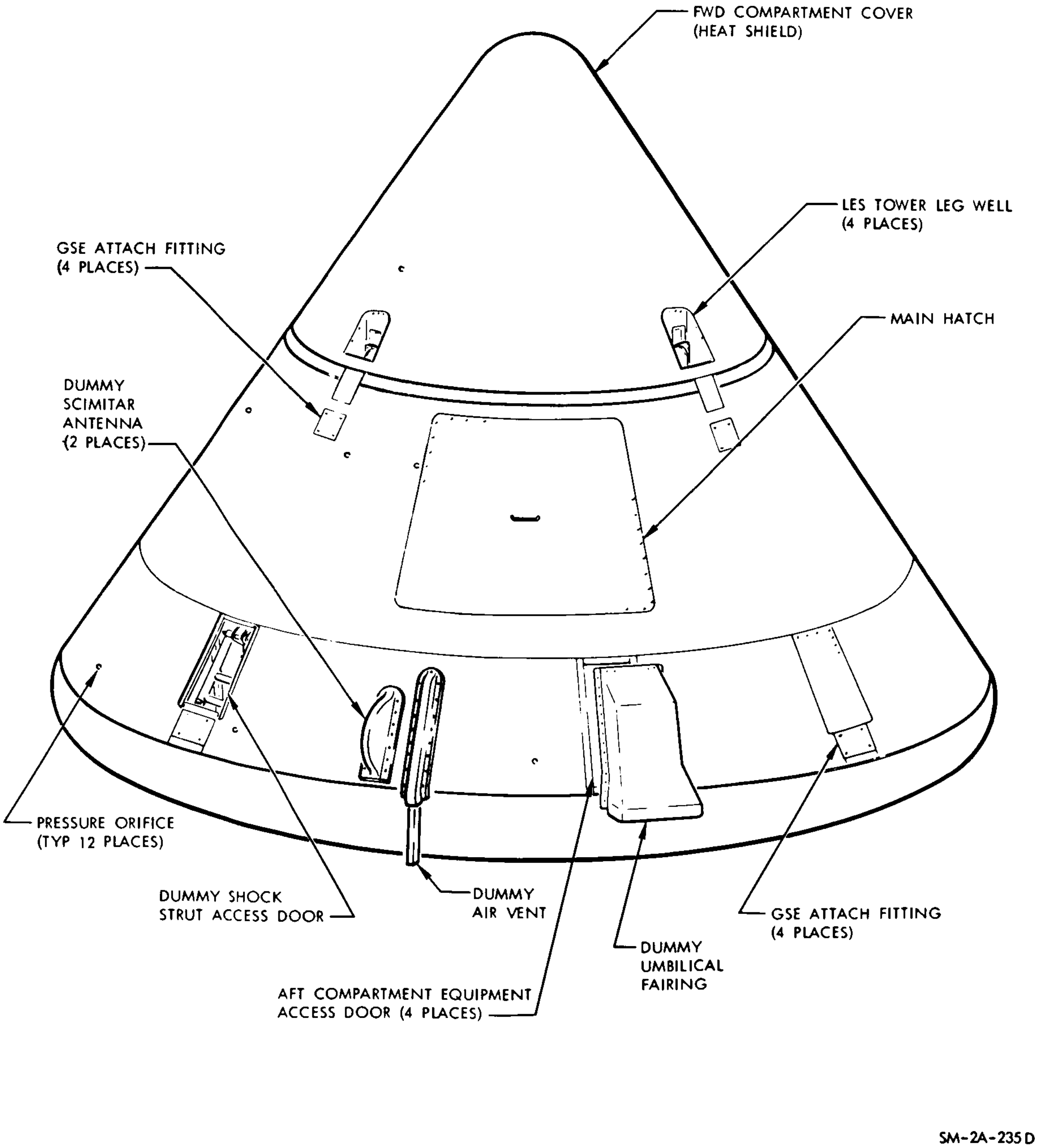


Figure 2-6. Command Module

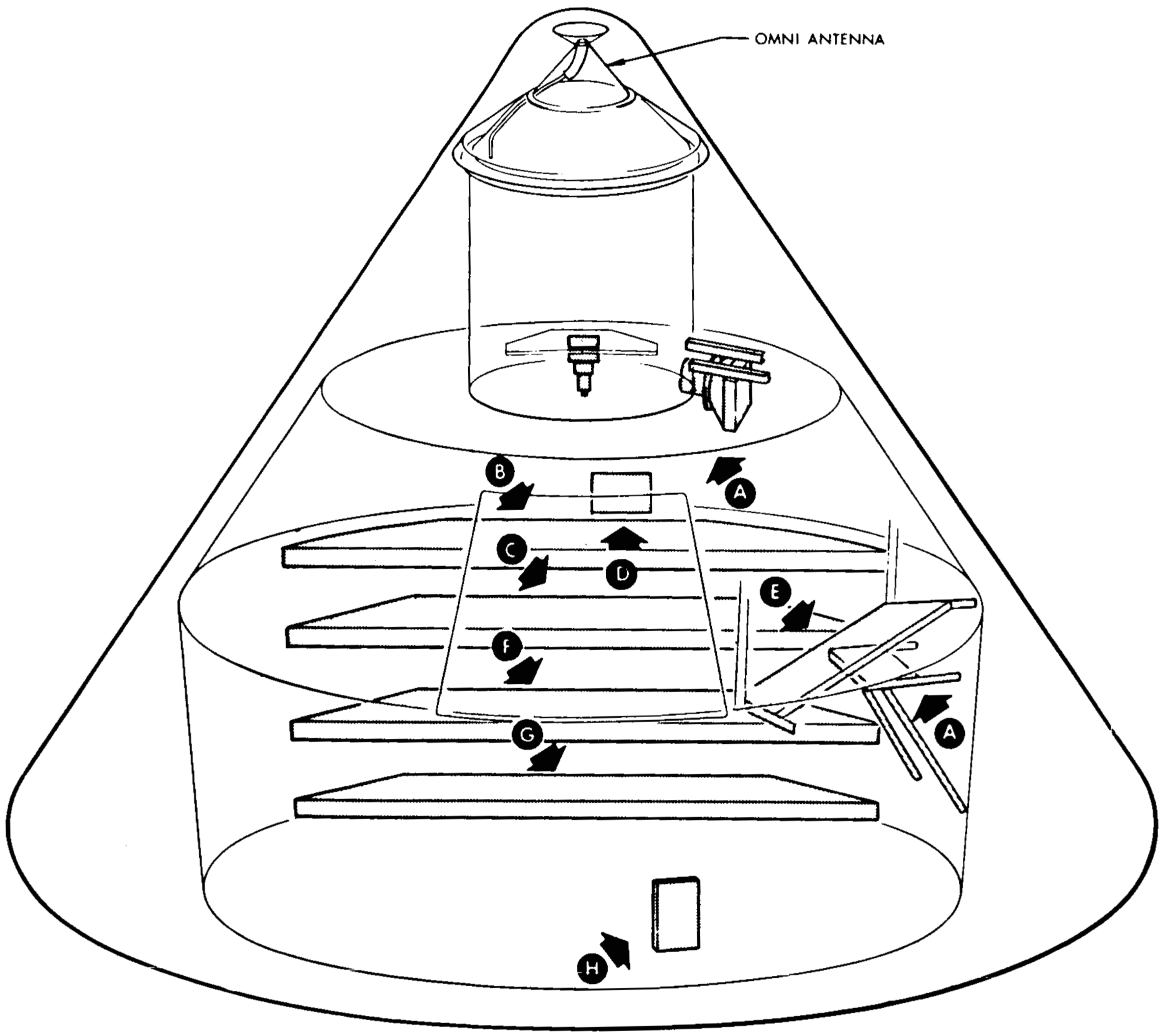


Figure 2-7. Command Module Interior (Sheet 1 of 5)

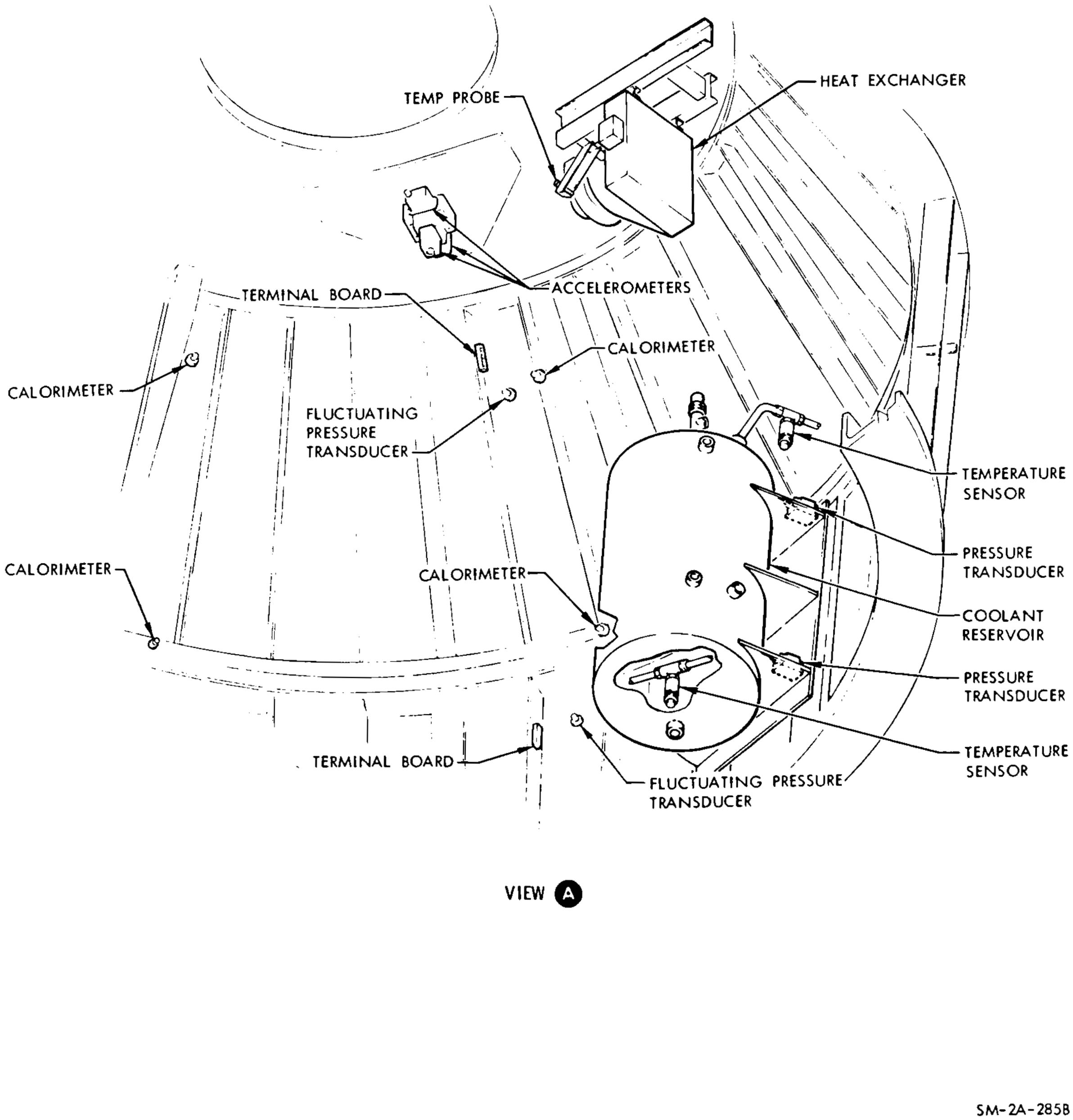


Figure 2-7. Command Module Interior (Sheet 2 of 5)

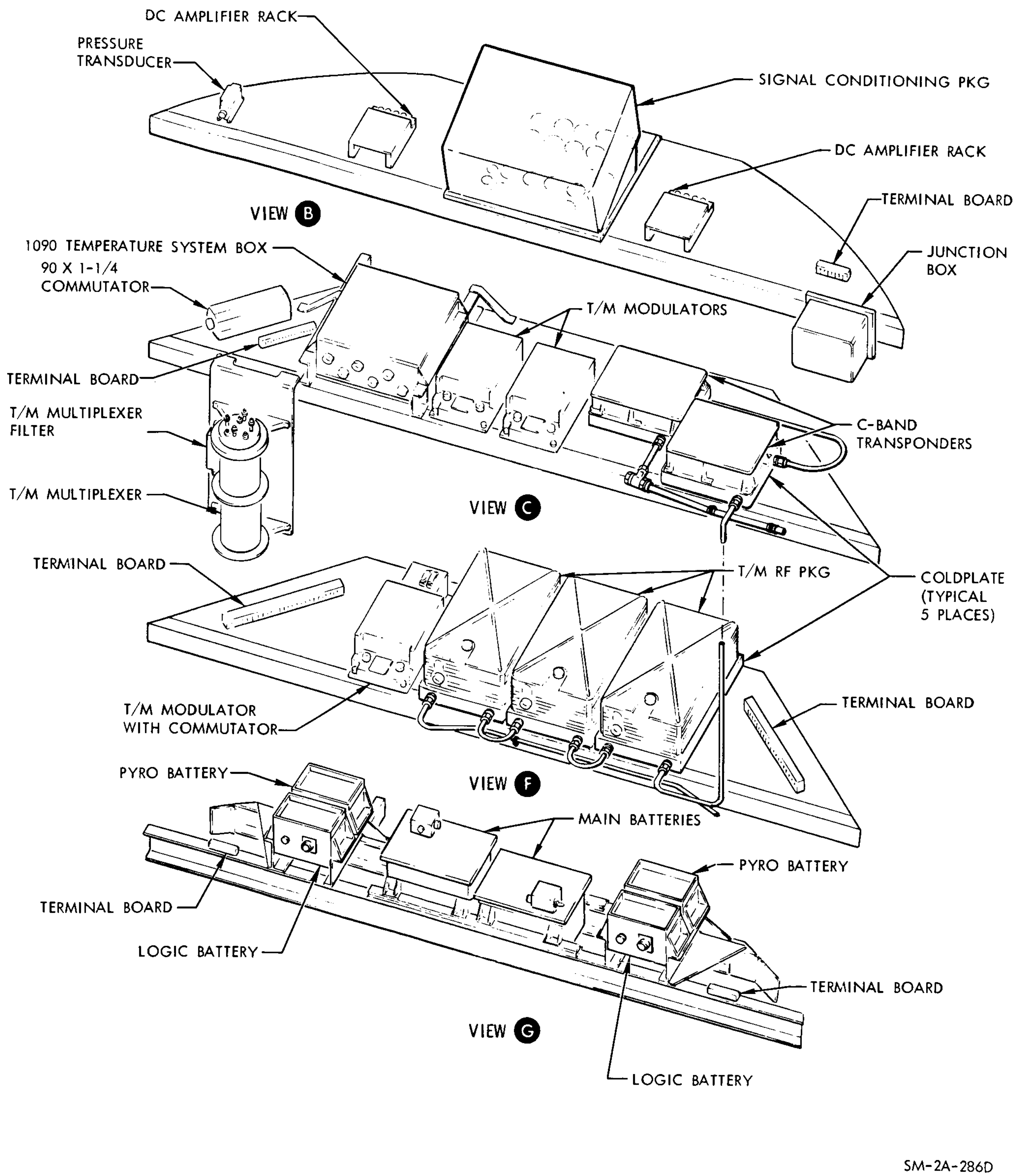


Figure 2-7. Command Module Interior (Sheet 3 of 5)

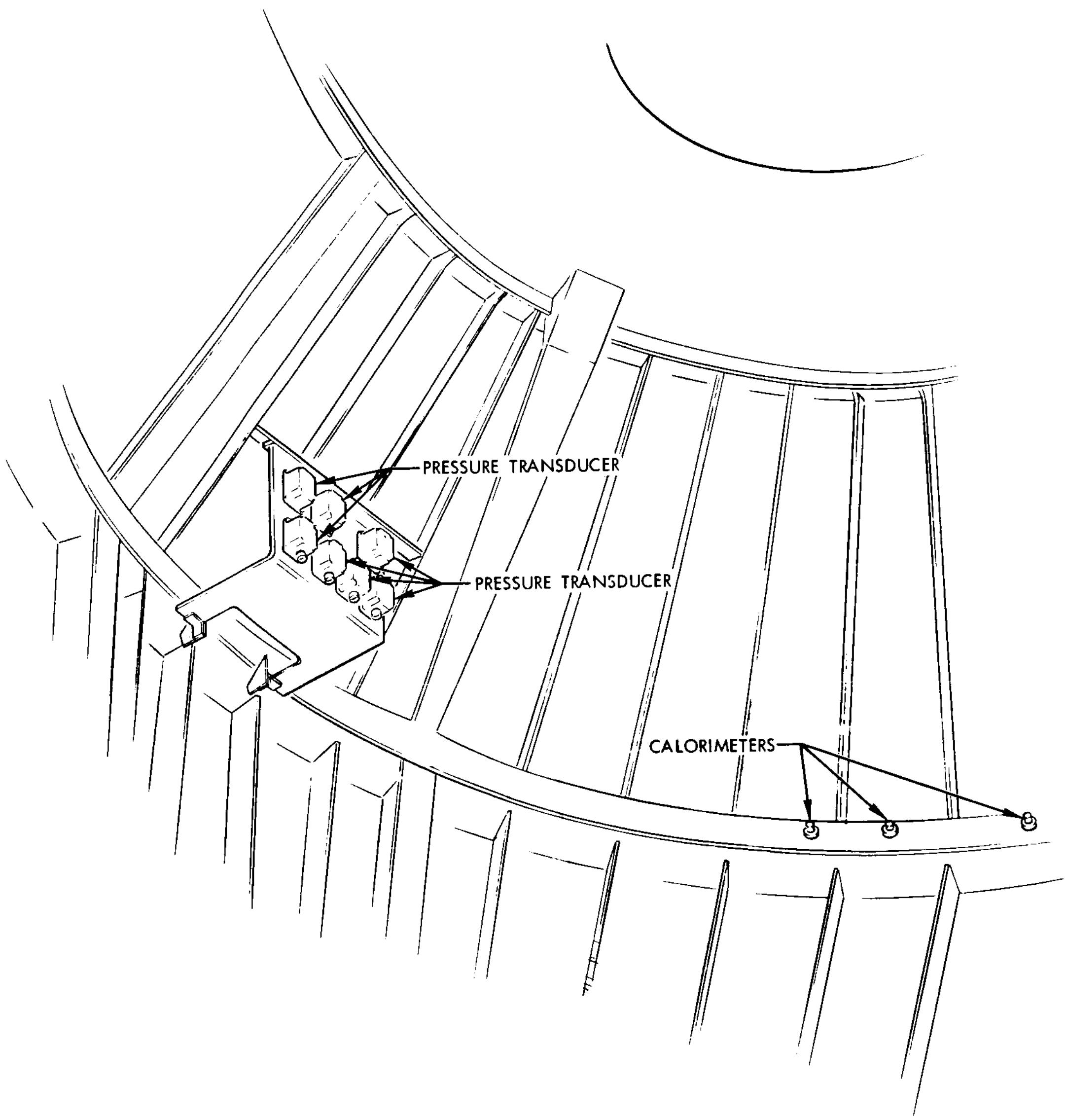


Figure 2-7. Command Module Interior (Sheet 4 of 5)

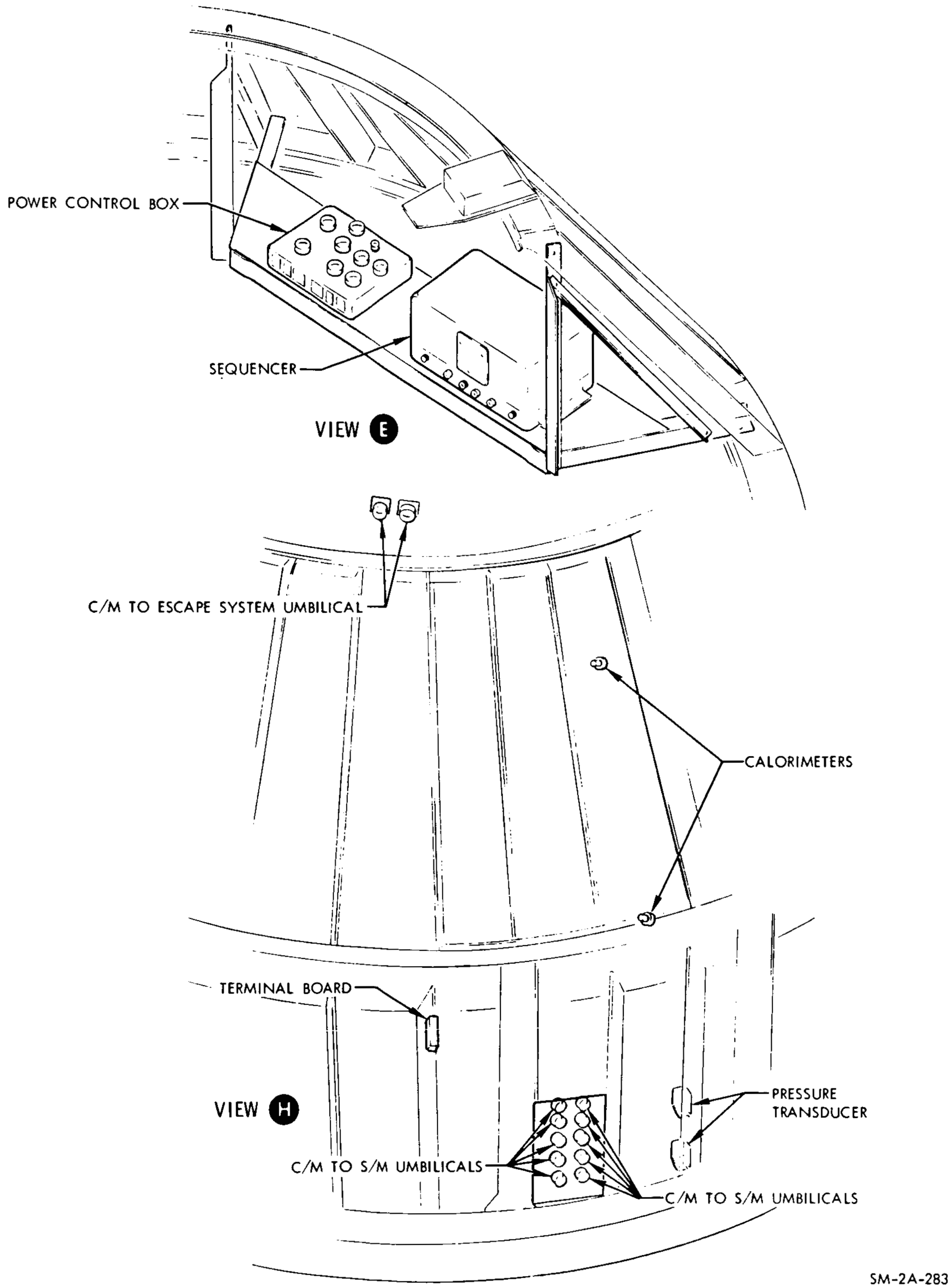


Figure 2-7. Command Module Interior (Sheet 5 of 5)

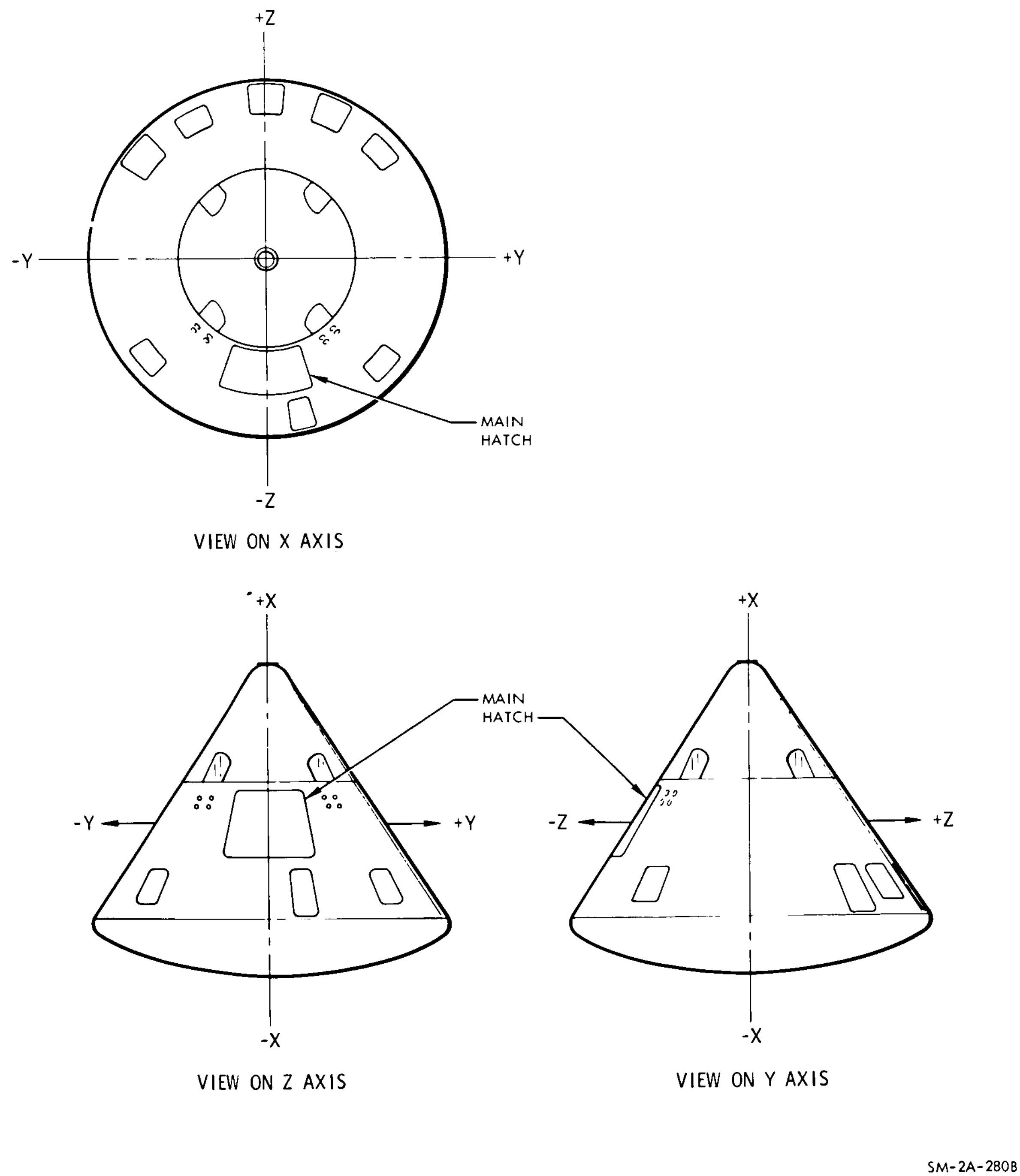


Figure 2-8. Command Module Reference Axis

2-23. AFT HEAT SHIELD.

2-24. The aft heat shield forms the convex base of the command module. It is constructed of aluminum honeycomb bonded to the inner and outer skins of the laminated fiberglass. Three adjustable struts (dummy shock struts) and one tension tie join the aft heat shield to the command module basic structure. (See figure 2-9.) Two holes are provided in the shield for installation of the umbilical electrical connectors. Nine holes are provided to permit attachment of the service module to the command module structure. Six of the holes are for the command module bearing points; the other three are for the tension-tie bolts. (See figure 2-10.)

2-25. INTERIOR.

2-26. The interior (crew compartment) area of the command module contains shelves and brackets for mounting the electrical power, R&D instrumentation, and equipment cooling systems. (See figure 2-7.) The interior area is insulated from the side walls with a quilted fiberglass material. The insulation helps to provide and maintain a constant temperature of not greater than 150 degrees Fahrenheit and to reduce the heat flow inside the compartment.

2-27. SERVICE MODULE, INSERT, AND ADAPTER. (See figure 2-11.)

2-28. The service module includes the insert and is used in the boilerplate 15 configuration primarily to transmit loads from the launch vehicle to the spacecraft. The command modules rests on the service module at six compression bearing points. Three tension-tie bolts hold the command module mating bearing points firmly seated. The six bearing bolts are adjusted to facilitate command module-to-service module alignment. An exterior non-structural fairing is located between the command module and the service module. The fairing houses a non-functioning separation mechanism, a support structure for distributing basic loads imposed by the command module to the service module, and fixed umbilical connections between the two modules. The command module and service module will not be separated during the mission; and, therefore, no pyrotechnics are installed. The service module-to-insert and insert-to-adapter interfaces are joined with 24 bolts each. The adapter is bolted to the instrument unit using 32 bolts. The holes for these 32 bolts are cadmium plated to provide electrical bonding.

2-29. A part of the spacecraft instrumentation system is located in the service module, listed as follows:

Service module (between stations 1785.596 and 1661.596, figure 1-1)
- Seven calorimeters
- Two strain gages
- Eleven fluctuating pressure transducers
- Three vibration transducers
- Two accelerometers
- One acoustical-sensing device.

Adapter (between stations 1609.596 and 1517.596, figure 1-1)
- Four strain gages
- One calorimeter
- Two vibration transducers
- Two fluctuating pressure transducers.

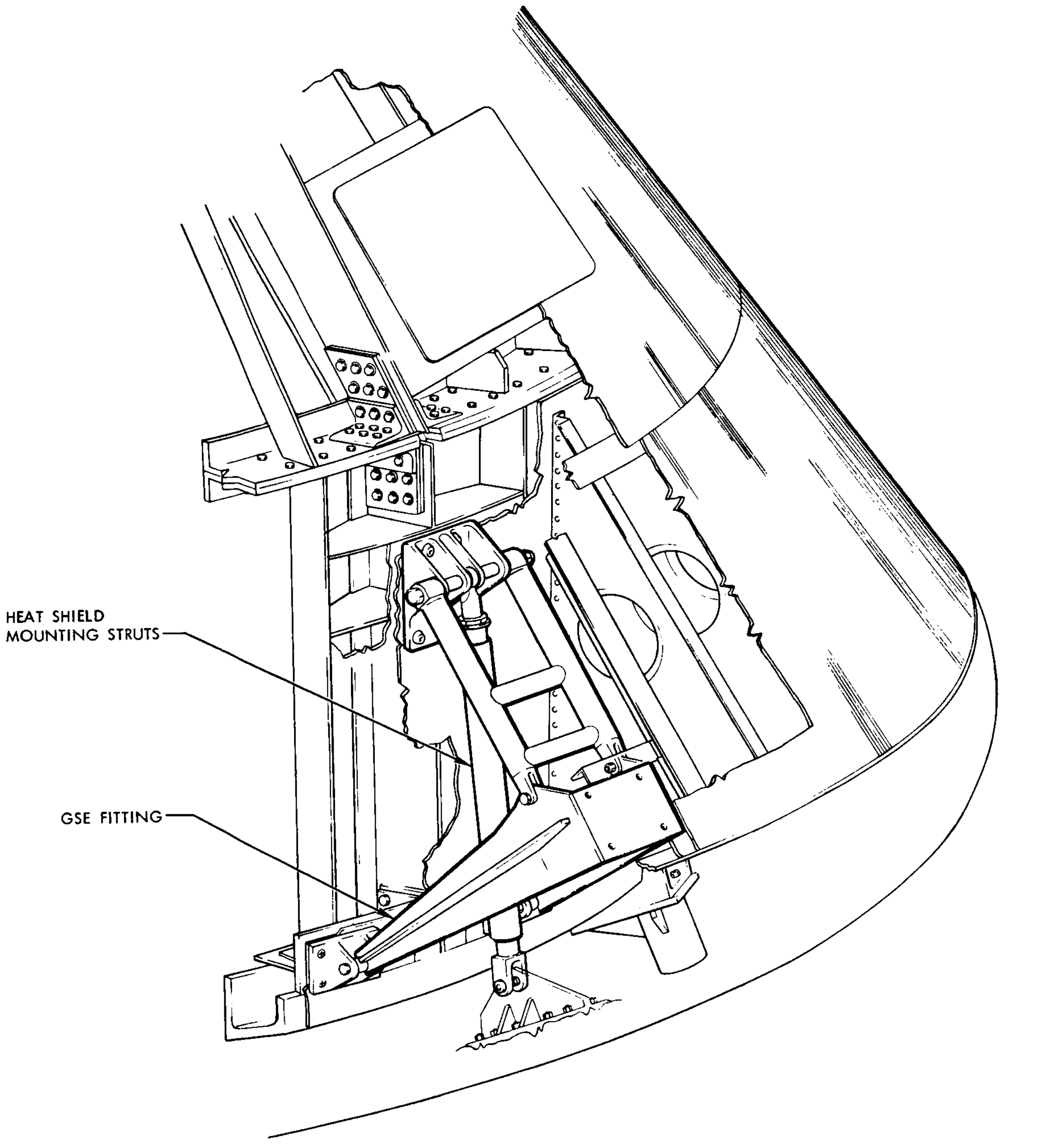


Figure 2-9. Dummy Shock Strut and GSE Attach Fitting

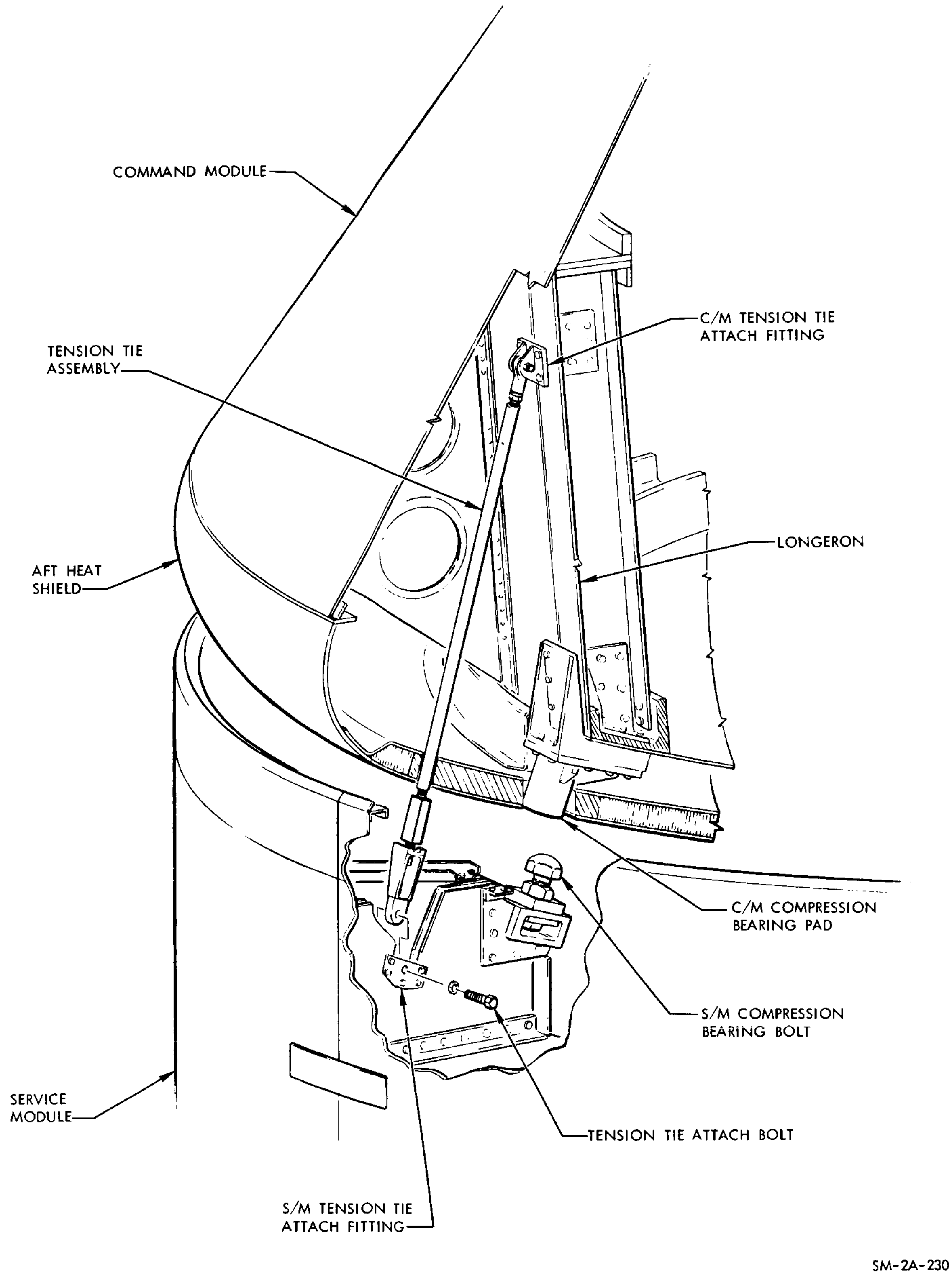


Figure 2-10. Service Module Tension Tie

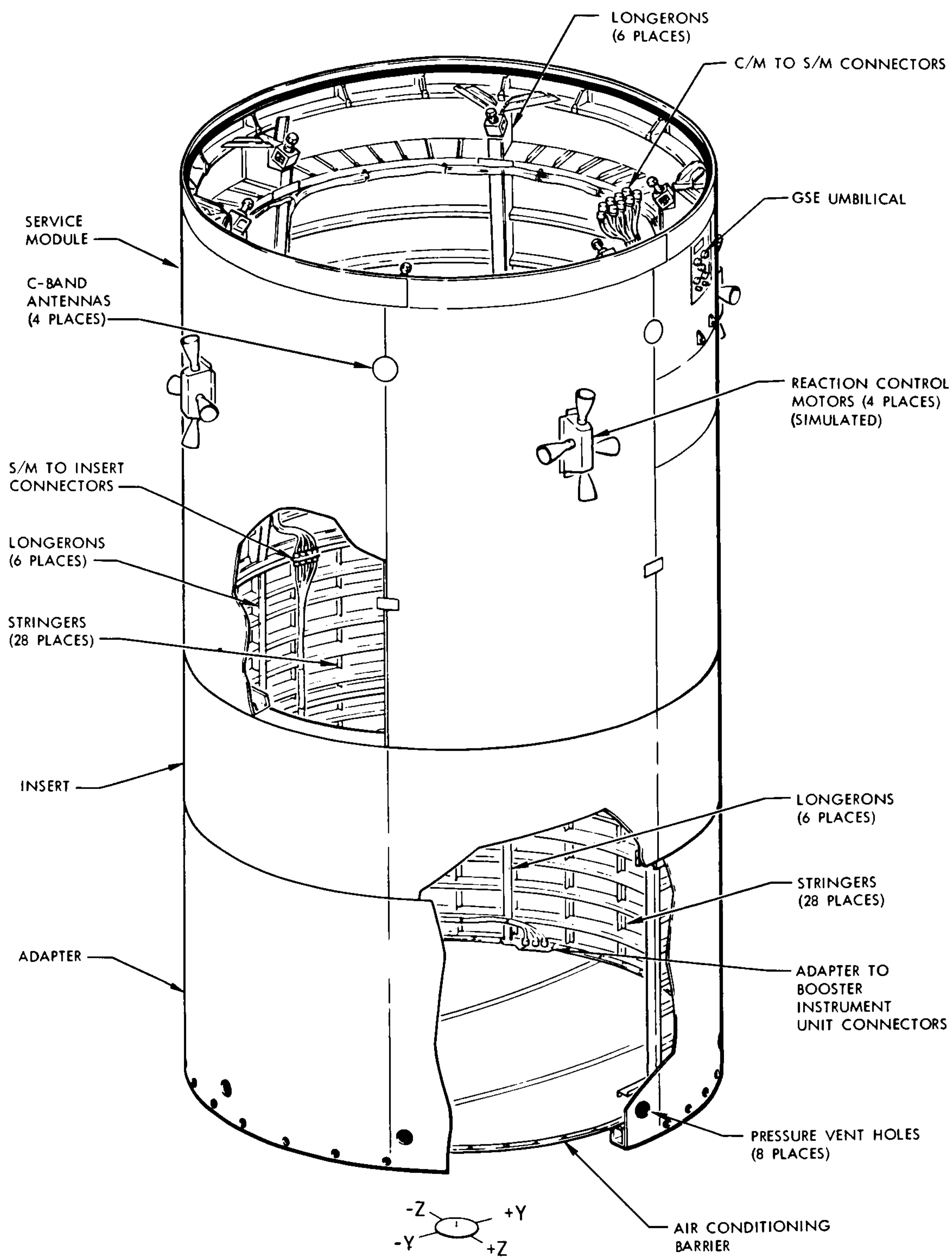


Figure 2-11. Service Module and Adapter

2-30. Ballast is installed in the service module and adapter to simulate weight and center of gravity of the spacecraft. Fiberglass reaction control system nozzles are mounted in place on the service module to simulate external configuration.

2-31. The adapter contains Apollo-Saturn interface wiring and an air-conditioning barrier in addition to the instrumentation (paragraph 2-29). The air-conditioning barrier consists of a double layer of nylon cloth impregnated on both sides with a chloroprene rubber compound. The barrier forms a bulkhead at the extreme aft end of the adapter.

2-32. STRUCTURE.

2-33. The service module, insert, and adapter are cylindrical, of semimonocoque type structure, 154 inches in diameter, with an aluminum outer skin. The service module (less insert) is 124 inches in length. The skin is riveted to aluminum ring frames attached to six longerons. The longerons are T-shaped, the rim part being fabricated of steel and the web of aluminum.

2-34. The insert is 52 inches in length. The skin is riveted to upper and lower ring frames. The upper frame is composed of aluminum angles and webs riveted together; the lower frame is constructed of rectangular aluminum tubing. The upper and lower ring frames are riveted to six steel and aluminum longerons and 28 aluminum stringers.

2-35. The adapter is 92 inches in length. The skin is riveted to longerons and stringers. Eight holes in the aluminum skin, evenly spaced around the aft end of the adapter, provide venting for pressures which may build up in the adapter.

2-36. INTERFACE EQUIPMENT.

2-37. Boilerplate 15 interface equipment consists of bolts, tension ties, and umbilical connectors.

2-38. TENSION TIES. (See figure 2-10.)

2-39. COMMAND MODULE-TO-SERVICE MODULE TENSION-TIE BOLTS. The tension-tie bolts utilized to bolt the command module to the service module are steel rod and turnbuckle assemblies. The assemblies are cadmium plated. The turnbuckle is used to preload the command module to the service module compression bearing points. The assemblies are approximately 42 inches long. Two of the assemblies use 7/8-inch hexagon steel rods 28.5 inches long. The third tie at longeron No. 1 uses 1-1/4-inch round steel rod 28.6 inches long on which hexagonal wrench flats have been machined. No pyrotechnic charges are installed on boilerplate 15 configuration. The tension tie at longeron No. 1 also is utilized as a vertical strut to help hold the aft heat shield in place.

2-40. UMBILICAL CONNECTORS.

2-41. The umbilical connectors on boilerplate 15 consist of electrical connectors and plugs located in the planes-of-separation of the modules, a GSE umbilical connector for ground support equipment, and a coolant umbilical connector. These connectors join the electrical systems of the modules while the modules are attached and provide a means of disconnecting the electrical systems upon module separation. There is no requirement for module separation during boilerplate 15 mission; therefore, the necessary hardware for umbilical disconnect is omitted except for GSE separation. The GSE umbilical supplies the electrical power while the boilerplate is on the pad. The coolant umbilical supplies the fluid coolant from GSE equipment on the pad.

2-42. GSE UMBILICAL CONNECTOR. A GSE umbilical is located in the skin of the service module approximately 18 inches below the top, on the +Z-plane (figure 2-8). This umbilical is equipped with a primary (pneumatic) and a backup (hydraulic) release mechanism. Both systems are armed by a signal from NASA control GSE. Pneumatic and hydraulic pressures are supplied by facility equipment. On initial command, a solenoid actuates the nitrogen pressure which ejects the umbilical. If this system fails to operate, 10 milliseconds later, a hydraulic actuator trips a lanyard which then disconnects the umbilical.

2-43. COMMAND MODULE-TO-SERVICE MODULE UMBILICAL CONNECTORS. Umbilical connector receptacles are recessed into the outer surface of the aft heat shield of the command module. They are approximately 12 inches from the outer edge and located near longeron No. 6. The receptacles are part of the command module aft compartment wiring installation. The plug portions of the connectors are part of the service module wiring installation.

2-44. SERVICE MODULE-TO-INSERT UMBILICAL CONNECTOR. Umbilical connector receptacles on the aft separation plane of the service module connect the plugs located in the extension forward end.

2-45. ADAPTER-TO-INSTRUMENT UNIT UMBILICAL CONNECTOR. Umbilical connector receptacles on the aft separation plane of the adapter, connect to plugs located in the forward end of the booster instrument unit. The instrument unit will not be separated from the adapter.

2-46. LAUNCH VEHICLE. (See figure 1-1.)

2-47. The boilerplate 15 launch vehicle is a Saturn I configuration (designated SA-6) consisting of a Saturn S-I first stage, a Saturn S-IV second stage, and a booster instrument unit.

2-48. FIRST STAGE.

2-49. The S-I stage is powered by eight Rocketdyne H-1 engines with a total thrust of 1,500,000 pounds. Propellants for these engines consist of 850,000 pounds of oxidizer LO_2 and fuel RP-1. The general appearance is cylindrical with aerodynamic stabilizing fins at the extreme aft end of the cylinder. The airframe is approximately 21 feet in diameter and is approximately 80 feet in length. First stage engine cutoff occurs 147.7 seconds after ignition. An S-I/S-IV interstage section 18 feet in diameter is jettisoned with the first stage.

2-50. SECOND STAGE.

2-51. The S-IV stage is powered by six Pratt & Whitney RL10-A3 engines with a total thrust of 90,000 pounds. Propellants for these engines consist of 100,000 pounds of oxidizer LO_2 and fuel LH_2. The airframe is approximately 18 feet in diameter with the forward end tapering to 13 feet to interface with the instrument unit and the spacecraft. The S-IV booster burns 473.8 seconds, placing the booster, instrument unit, and spacecraft into orbit approximately 100 nautical miles from earth. No recovery is planned.

2-52. BOOSTER INSTRUMENT UNIT.

2-53. The instrument unit interfaces with the booster and spacecraft. It is approximately 13 feet in diameter and contains the guidance and control system, flight sequencers, booster telemetry system, tracking system, and electrical power system.

SECTION III

LAUNCH ESCAPE SYSTEM

3-1. PURPOSE.

3-2. The boilerplate 15 launch escape system will demonstrate the structural adequacy of the design by the static and dynamic loads imposed while on the ground, and during lift-off and boost phases.

3-3. OPERATIONAL DESCRIPTION.

3-4. The operational description of the launch escape system (from prelaunch to tower jettison) is as follows: The mission sequencer logic bus and tower sequencer pyro bus are armed prior to booster ignition by manual commands. The mission sequencer logic circuitry arms an S-I/S-IV separation relay in the booster instrument unit. At time of S-I/S-IV separation, the relay closes and a 12-second timer in the instrument unit is activated. At time runout, the separation-plus-12-second signal operates the relay motors in the tower sequencers, closing the motor and separation squib contacts, and thus supplying 28 volts simultaneously to all jettison motor and separation squibs. Figure 3-1 is a functional block diagram showing sequence of events. Table 3-1 is a time history of the events leading to tower jettison.

Table 3-1. Time History of Events Leading to Tower Jettison

Time (Seconds from Ignition)	Event	Velocity (Feet/Second)	Altitude (Feet)	Dynamic Pressure (Pounds/Foot^2)	Flight Path Angle (Deg)	Range (KM)	Mach No.
T - 3.42	S-I ignition	0	0	0	90	0	0
T + 0	Lift-off		0	0	90		0
T + 69.5	Max Q	1481	38,770	720	58.7		1.5
T + 141.7	S-I inboard Eng. cutoff	8212	198,187	28.3	25.8		7.9
T + 147.7	S-I burnout	8718.3	219,886	11.0	24.8	50	8.9
T + 150.7	S-IV ignition	8678.4	230,750	7.0	24.4	55	9.1
T + 161.7	Escape tower	8752.5	265,581	1.3	22.8	67	10.3

3-5. MOTOR IGNITION.

3-6. Each motor ignition system contains two electrical hot wire initiators threaded into pyrotechnic cartridges which fire the igniter of the motor. Redundant initiators are employed for increased reliability. Current passing through low resistance wires detonates the cartridge, which ignites the rocket motor igniter. The initiator body is 1 inch long with a 3/4-inch flange, 0.45 inch from the threaded end. The electrical header contains two independent hot wire circuits and four pins. The initiator ignites within 10 milliseconds when one bridgewire is subjected to a firing current of 3.5 amperes. The pressure level of the explosive charge is produced within 12 milliseconds after application of current. The igniter for the tower jettison motor is installed in the aft dome of the rocket motor. The propellant grain is an 8-point configuration of boron potassium nitrate.

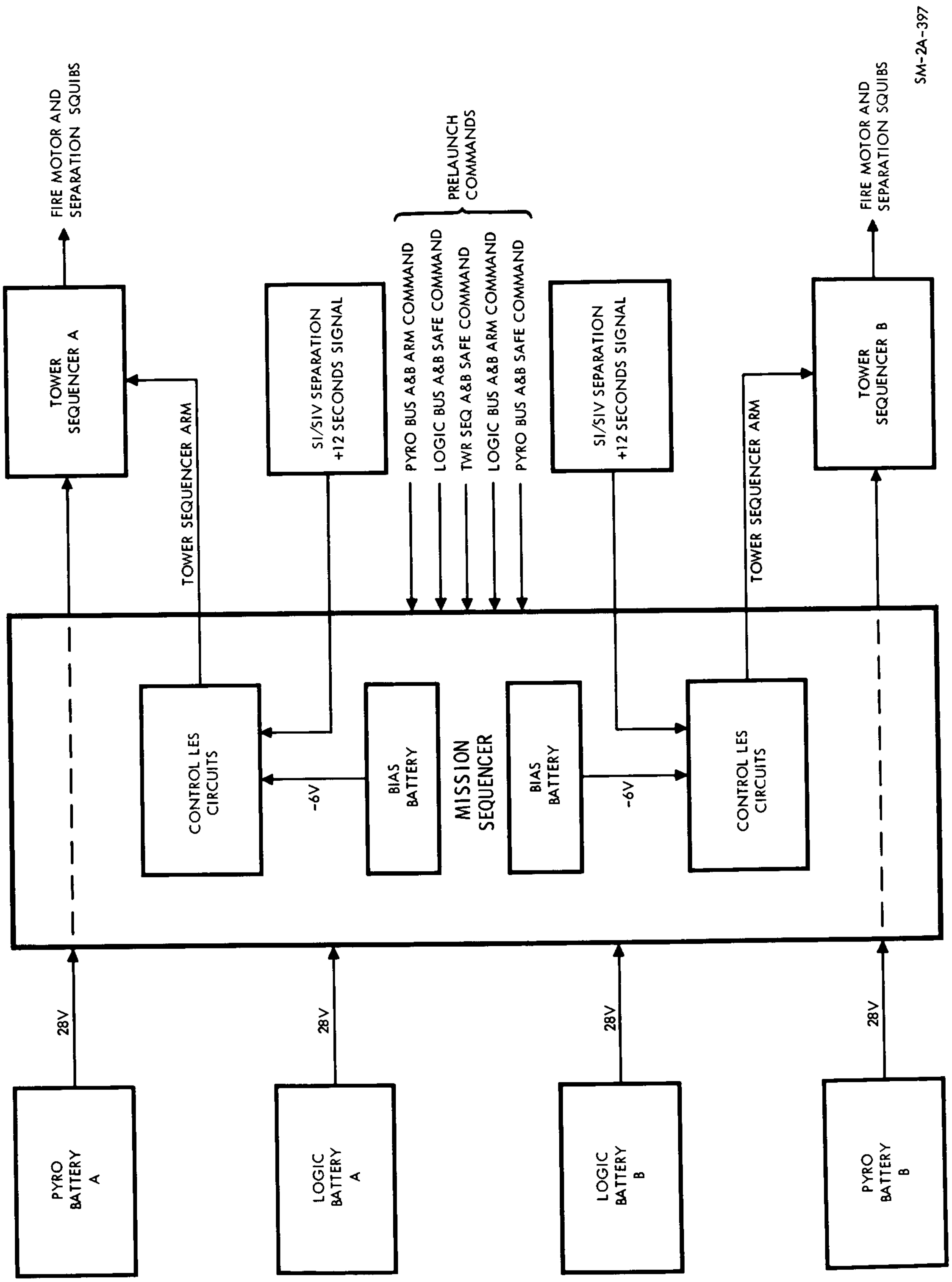


Figure 3-1. Launch Escape System Functional Block Diagram

3-7. TOWER SEPARATION.

3-8. The tower separation system consists of four explosive bolts (figure 2-2) that secure the tower to the command module. Each bolt contains two charges, the explosive bolt charge and the shaped charge. The explosive bolt charge is contained in the center of the the bolt and the shaped charge is just below the bolt head. Both charges are fired simultaneously. Release of the tower is accomplished by simultaneous detonation of the four explosive bolts. The hot wire initiators for the bolts are ignited by 28-volt d-c signals received from the mission sequencer through the tower sequencers. The initiators will detonate to fire the explosive bolts within 5 milliseconds. To accomplish tower jettison, the mission sequencer simultaneously initiates detonating signals to the explosive bolts and to the tower jettison motor hot wire initiators. The entire launch escape assembly is released and pulled clear of the spacecraft trajectory. The tower to command module umbilical connections are disconnected automatically when tower separates from the command module.

3-9. LAUNCH ESCAPE MOTOR.

3-10. The launch escape motor is a solid-propellant motor with four nozzles nominally canted 35 degrees from the mean motor centerline. The resultant thrust vector of 2.3 degrees is obtained by a difference in exhaust nozzle throat area. The propellant capacity is approximately 3000 pounds, giving the motor a gross weights of approximately 4800 pounds. Effective thrust developed is approximately 155,000 pounds at 36,000 feet altitude, at 70 degrees Fahrenheit grain temperature. Burning time is 3 seconds at nominal thrust with burnout at 8 seconds.

3-11. PITCH CONTROL MOTOR.

3-12. The pitch control motor is a solid-propellant reaction motor. The motor provides up to 3400 pounds of thrust for 0.5 second in the minus Z-direction, producing a positive pitch rate about the Y-axis to provide displacement.

3-13. LAUNCH ESCAPE TOWER JETTISON MOTOR.

3-14. The tower jettison motor is a solid-propellant motor that provides the thrust for separation of the launch escape tower and related equipment from the command module. The jettison motor is mounted on top of the inert escape motor. Passive thrust vector control in the form of offset exhaust nozzles provides a trajectory that arcs slightly in the pitch-up direction. For operational characteristics of the jettison motor, refer to table 3-2.

Table 3-2. Operational Characteristics of Launch Escape Tower Jettison Motor

Thrust	33,000 pounds
Duration	1 second
Time required to reach 90-percent maximum thrust	75 to 125 milliseconds
Angles between resultant thrust axis and motor:	
Pitch plane	2 degrees ±30 minutes
Yaw plane	0 degrees ±30 minutes

3-15. MISSION SEQUENCER. (See figure 2-7, sheet 5, view E, and figure 3-2.)

3-16. The mission sequencer located in the command module controls the sequence of events that are necessary to execute a successful launch escape tower jettison operation. The sequencer contains the logic circuits to direct the timing and order of the electrically initiated steps of the mission. Complete redundancy of the entire sequential network is provided for reliability. The mission sequencer logic circuits send electrical signals to operate the motor switches in the tower sequencer for firing the explosive bolt squibs and igniting the tower jettison motor. Table 3-3 gives mission sequencer functions. In addition, the mission sequencer provides compatibility for monitoring critical events as they occur, thus providing an input to the instrumentation system.

3-17. TOWER SEQUENCERS. (See figures 2-3 and 3-3.)

3-18. Two tower sequencers are attached to the underside of the structural skirt. Each sequencer has one motor-driven switch. An output voltage from the mission sequencer drives each motor-driven switch to the ARM position. The switches then allow electrical power from the pyro bus to simultaneously fire the tower separation explosive bolts, shaped charges, and jettison motor igniter. The sequencer provides circuits for monitoring the functional status of the control circuits via GSE during checkout operations. Use of two sequencers provides total redundancy for reliability.

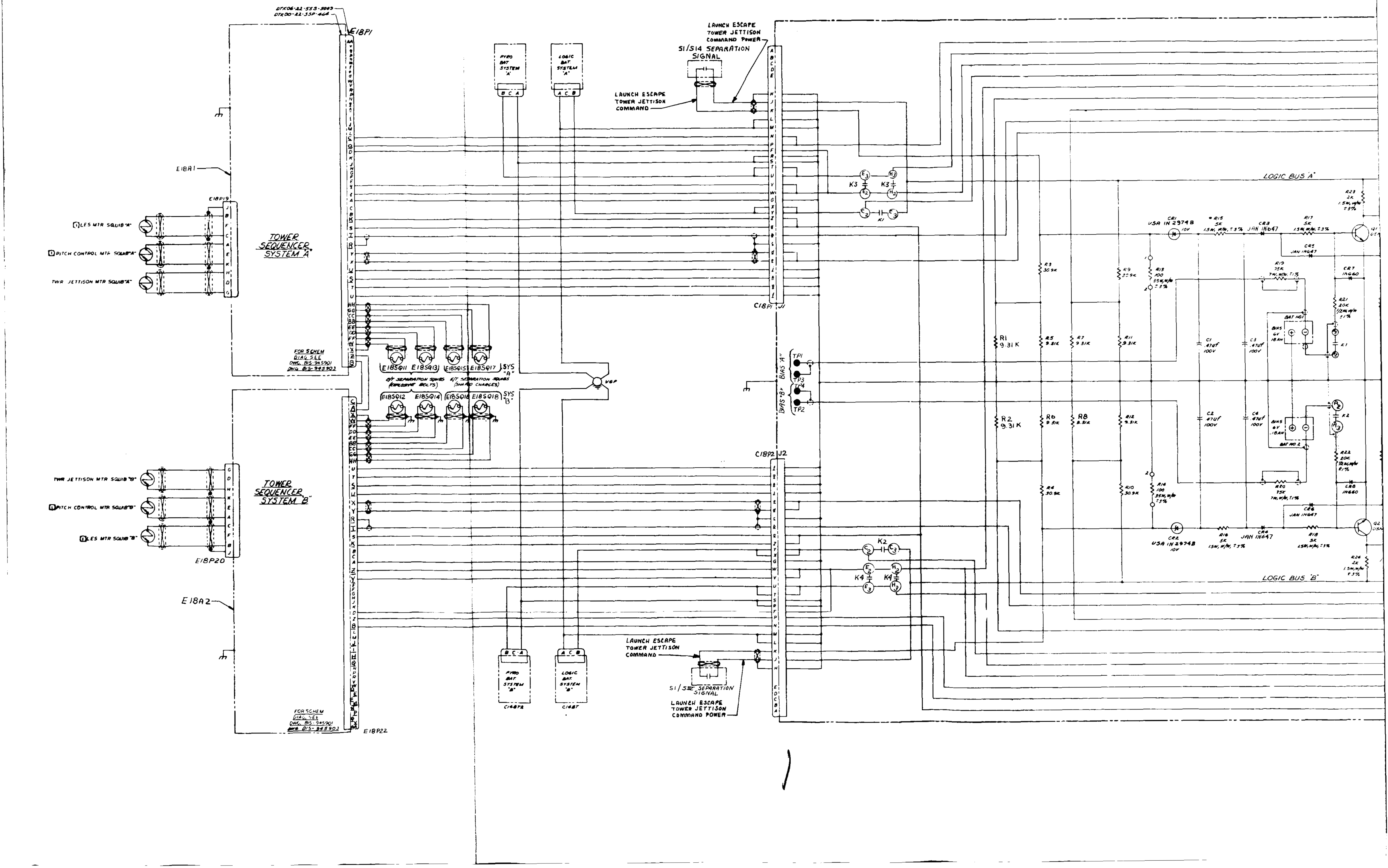
Table 3-3. Mission Sequencer Functions

Signal	Function	Time	Controlling Components	Signal Source
Logic bus A & B arm command	Supplies base voltage for transistorized switching network to energize coils of motor-driven switches C18K1 and C18K2.	Prelaunch	C18J4-b	GSE
Logic bus A & B	Supplies collector voltage to transistorized switching network to energize coils of motor-driven switches E18K1 and E18K2 and to arm contacts of S-I separation signal.	Prelaunch	C18K1 and C18K2, C18J4-X, C18J4-Y, C18J2-X, and C18J2-Y	Logic batteries A and B
Pyro bus A & B arm command	Supplies base voltage for transistorized switching network to energize coils of motor-driven switches C18K3 and C18K4.	Prelaunch	C18J4-V	GSE
Pyro bus A & B	Supplies voltage to firing contacts of E18K1 and E18K2.	Prelaunch	C18K3 and C18K4, C18J1-T, C18J1-U, C18J2-T, and C18J2-U	Pyro battery A

[redacted]

Table 3-3. Mission Sequencer Functions (Cont)

Signal	Function	Time	Controlling Components	Signal Source
S-I separation	Supplies base voltage to transistorized switching network to energize coils of motor-driven switches E18K1 and E18K2.	S-I separation plus 12 seconds	IV programer C18J1-J, C18J1-K, C18J2-J, and C18J2-K	Logic bus A and B
Launch escape tower jettison	Supplies firing voltage to tower jettison motor and launch escape tower separation squib initiators.	S-I separation plus 12 seconds	E18K1 and E18K2	Pyro bus A and B



E18P1
E18A1
E18P19
LES MTR SQUIB "A"
PITCH CONTROL MTR SQUIB "A"
TWR JETTISON MTR SQUIB "A"
TOWER SEQUENCER SYSTEM "A"
FOR SCHEM DIAG SEE DWG. 815-945901 DWG. 815-945903
PYRO BAT SYSTEM "A"
LOGIC BAT SYSTEM "A"
LAUNCH ESCAPE TOWER JETTISON COMMAND POWER
S1/S14 SEPARATION SIGNAL
LAUNCH ESCAPE TOWER JETTISON COMMAND
C18P1 J1
K3
K1
LOGIC BUS "A"
E18SQ11
E18SQ13
E18SQ15
E18SQ17
SYS "A"
E/T SEPARATION SQUIBS (EXPLOSIVE BOLTS)
E/T SEPARATION SQUIBS (SHAPED CHARGES)
E18SQ12
E18SQ14
E18SQ16
E18SQ18
SYS "B"
BIAS "A"
BIAS "B"
TP1
TP2
TP3
TP4
R1 9.31 K
R2 9.31 K
R8
CR1 USA IN 2974 B 10V
CR2 USA IN 2974B 10V
JAN IN647
BAT NO 1
BAT NO 2
LOGIC BUS "B"
K2
K4
C18P2 J2
TWR JETTISON MTR SQUIB "B"
PITCH CONTROL MTR SQUIB "B"
LES MTR SQUIB "B"
E18P20
TOWER SEQUENCER SYSTEM "B"
E18A2
FOR SCHEM DIAG SEE DWG. 815-945901 DWG. 815-945903
E18P22
PYRO BAT SYSTEM "B"
C14872
LOGIC BAT SYSTEM "B"
C1487
LAUNCH ESCAPE TOWER JETTISON COMMAND
S1/S14 SEPARATION SIGNAL
LAUNCH ESCAPE TOWER JETTISON COMMAND POWER

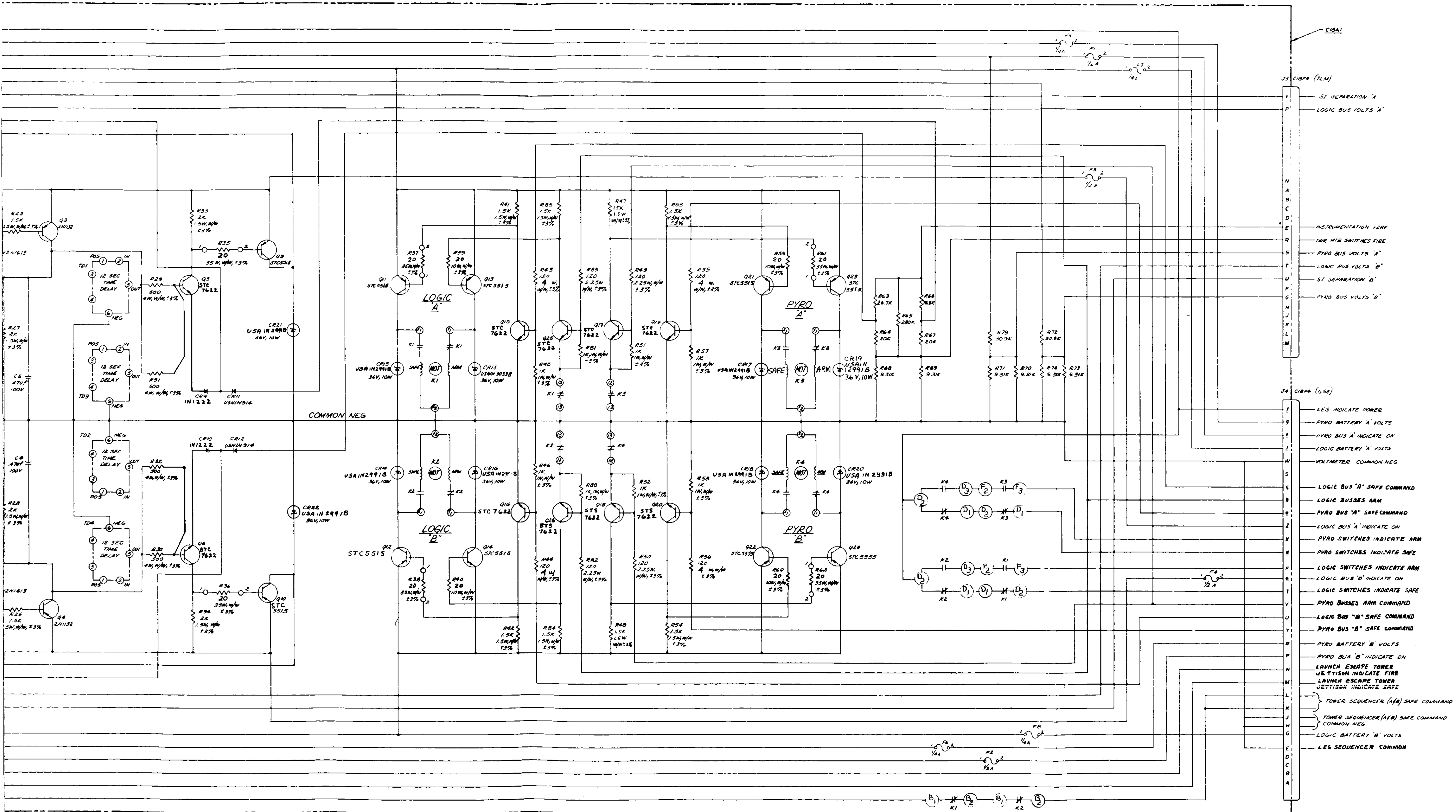


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Figure 3-2. Mission Sequencer Schematic Diagram

2

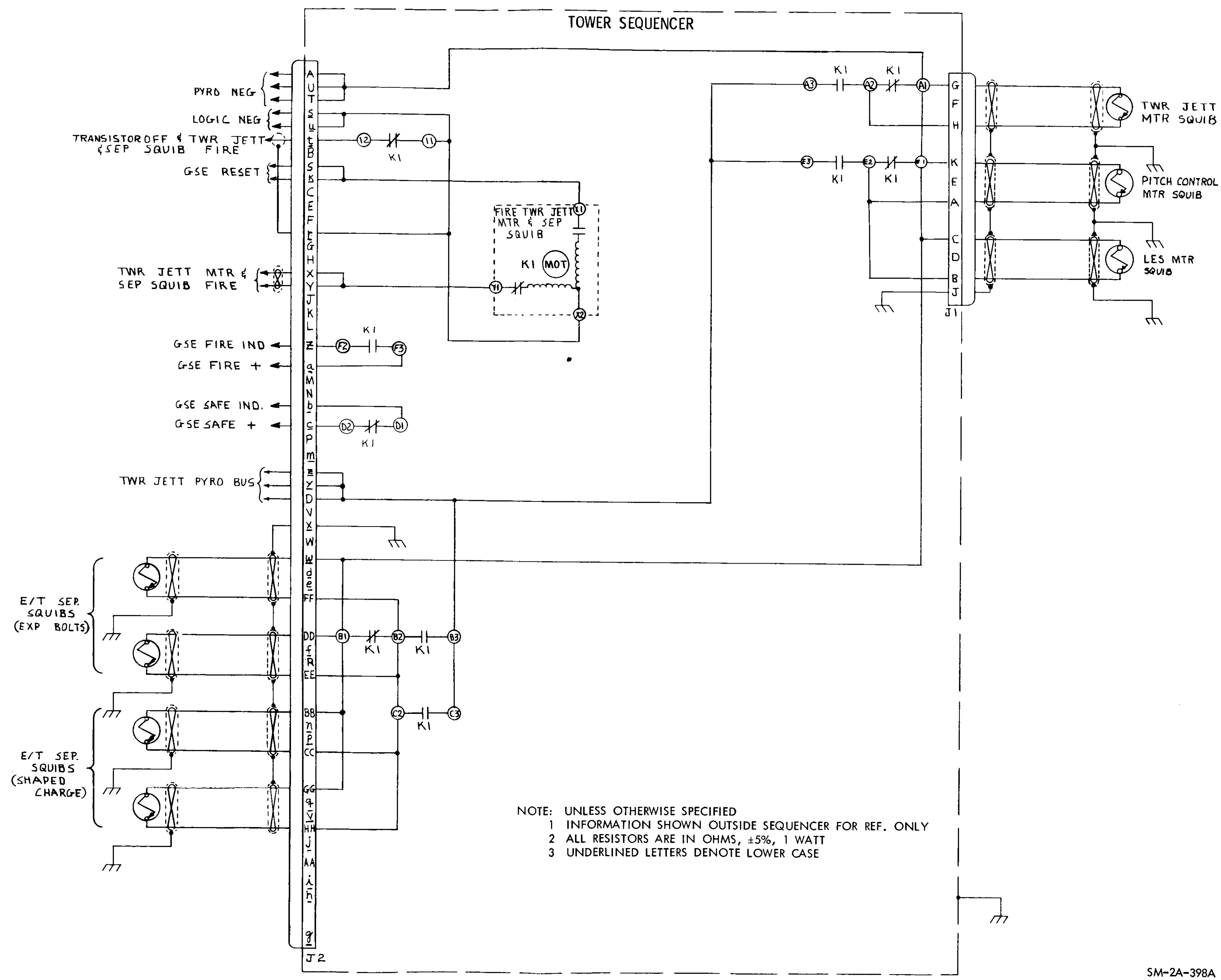


Figure 3-3. Tower Sequencer Schematic Diagram

SECTION IV

COMMUNICATIONS AND INSTRUMENTATION

4-1. PURPOSE.

4-2. The communications and instrumentation system provides a means of acquiring and conditioning preselected information and of transmitting this information to earth monitoring equipment. (Refer to table 4-1 for measurement list.) The system also provides for tracking of the spacecraft during the mission. The Q-ball contains some instrumentation equipment, the information being used for booster guidance system performance evaluation. The Q-ball system is not connected functionally with the Apollo communications and instrumentation system but is described in this section.

4-3. DESCRIPTION. (See figure 4-1.)

NOTE

For detailed descriptive and checkout information for the R&D electronic equipment furnished by NASA, refer to applicable NASA document.

4-4. COMMUNICATIONS EQUIPMENT.

4-5. Communications R&D equipment consists of the telemetry system and radar transponders.

4-6. TELEMETRY SYSTEM. The telemetry system consists of three FM/FM telemetry subsystems, one system containing two PAM channels, the transmitters of each operating into the antenna system. Besides the transmitter, each telemetry subsystem includes subcarrier oscillators and, in addition, subsystem A contains a 90 x 10 and a 90 x 1-1/4 commutator used for temperature measurements.

4-7. Transmitting frequencies of the three systems are as follows:

Telemetry system A	237.8 mc
Telemetry system B	247.3 mc
Telemetry system C	257.3 mc.

4-8. The antenna system consists of a multiplexer, a filter, and a VHF omniantenna. The antenna is located under a radome in the nose of the command module.

4-9. RADAR TRANSPONDERS. The two radar transponders operate in the C-band, receiving at 5690 mc and transmitting at 5765 mc. The transponders are interrogated by a 2-pulse code spaced at intervals of 3.5 microseconds between leading edges and followed by a 2.0-microsecond delay. The repetition rate will be consistent with range tracking requirements.

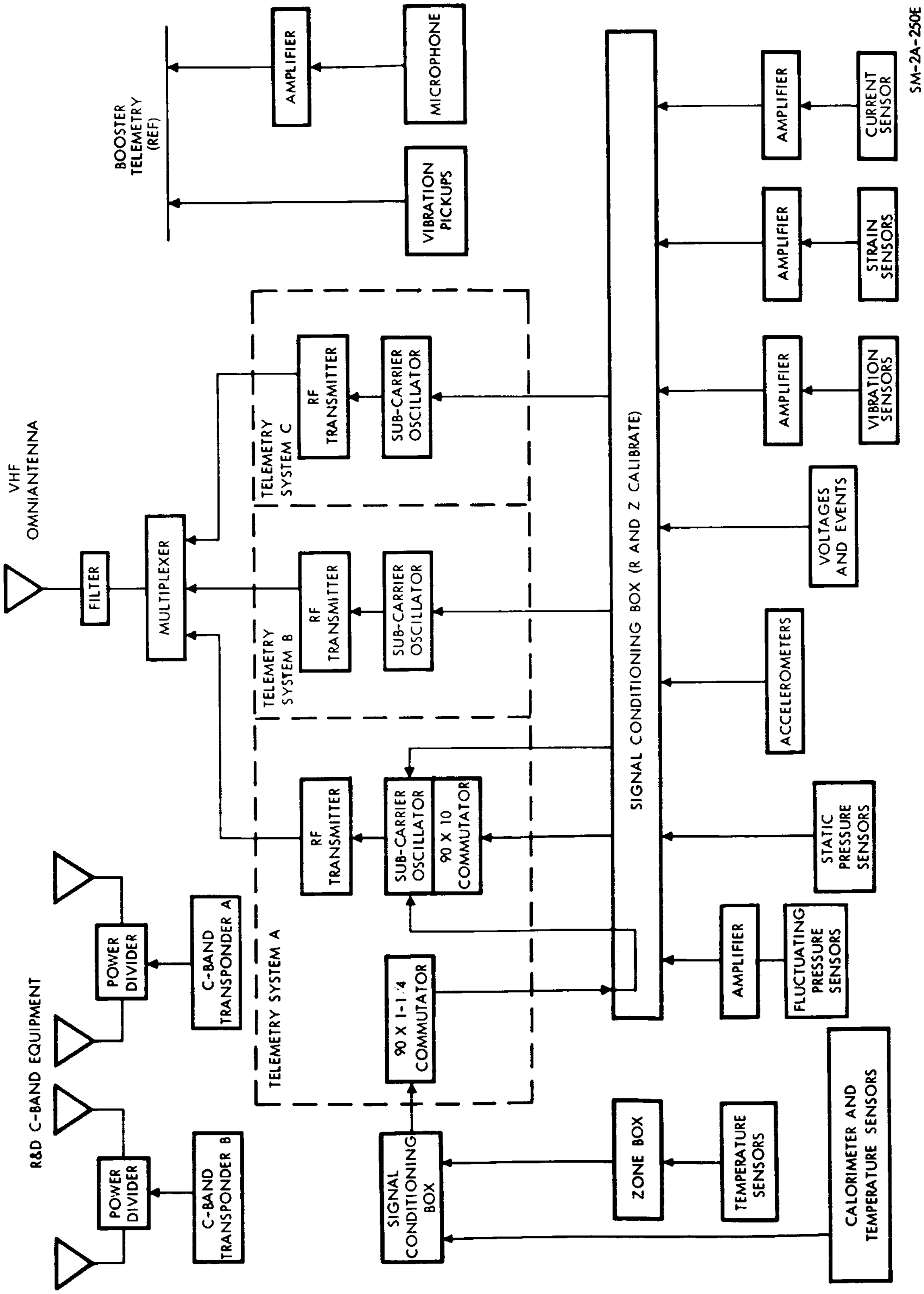
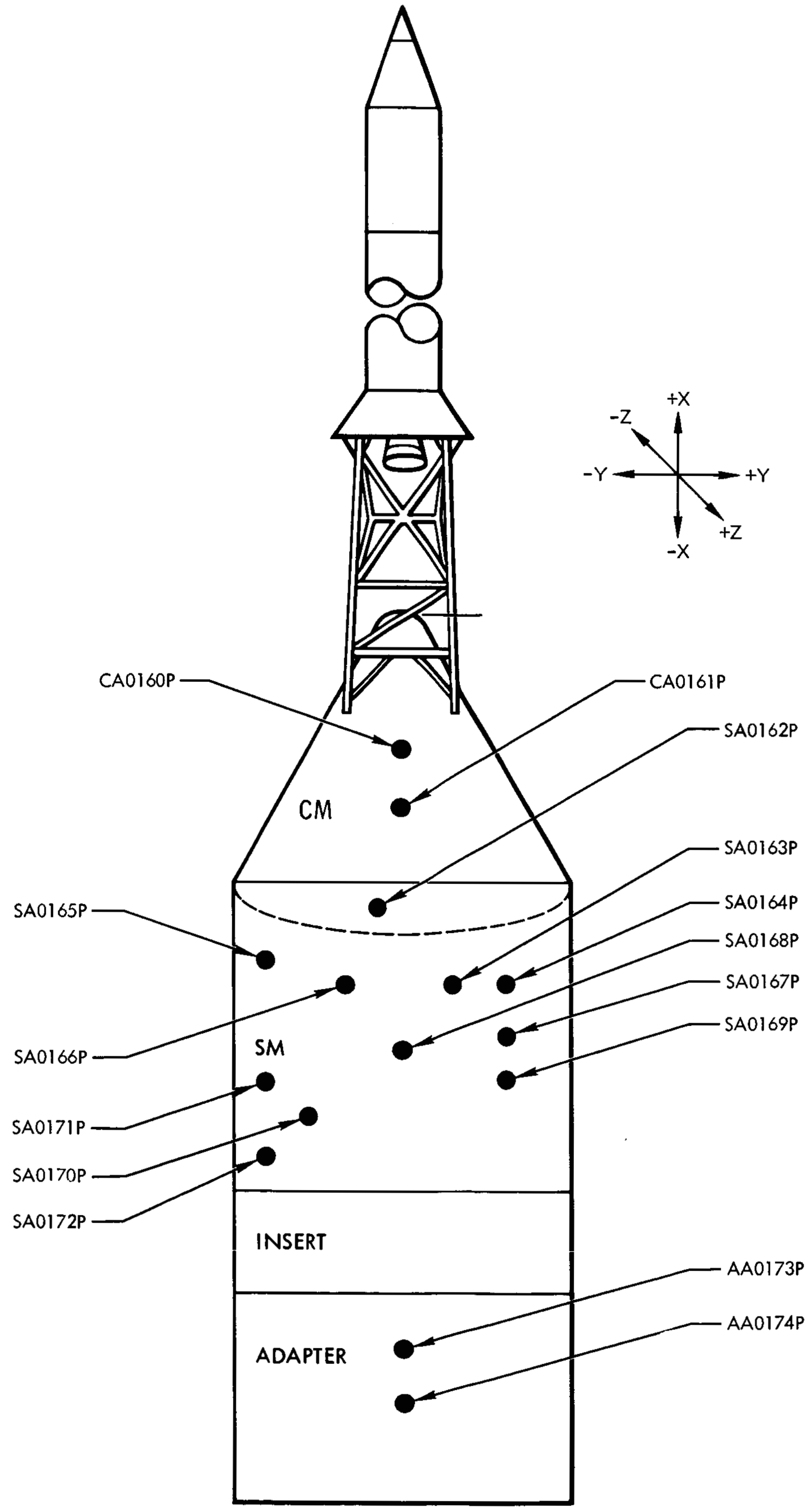
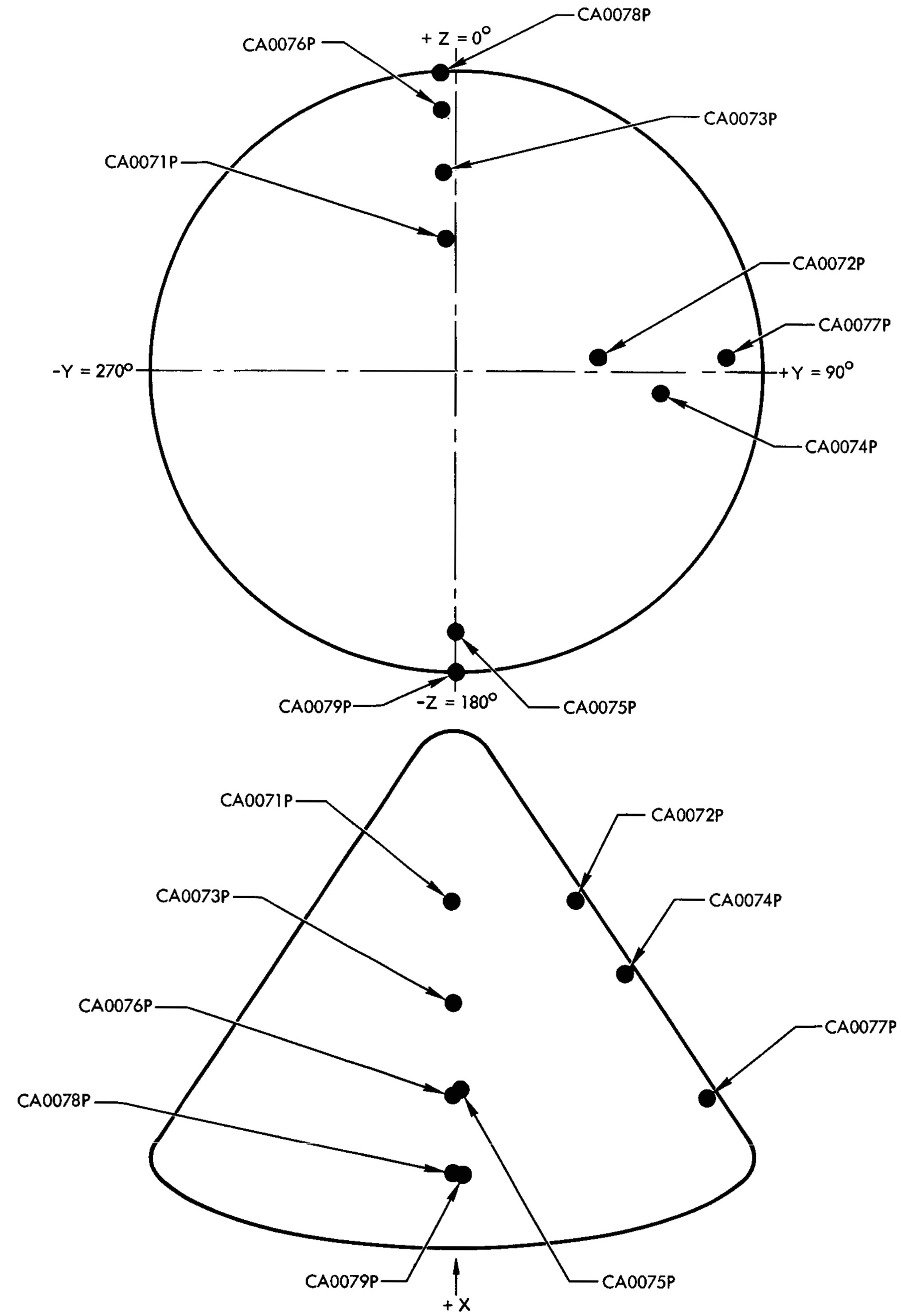


Figure 4-1. R&D Instrumentation Block Diagram



FLUCTUATING PRESSURE TRANSDUCERS (15)



STATIC PRESSURE TRANSDUCERS (9)

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Figure 4-2. R&D Instrumentation Locations (Sheet 4 of 6)

4-10. The radar transponder antenna system includes two power dividers and four cavity helical, flush-mounted antennas. The antennas are mounted 90 degrees apart around the upper section of the service module.

4-11. INSTRUMENTATION EQUIPMENT.

4-12. Instrumentation equipment includes the necessary transducers, sensors, and other devices to monitor physical and thermal effects of flight upon the spacecraft and to convert them into electrical signals suitable for telemetering. The devices are located in and on the spacecraft as shown in figure 4-2. Table 4-1 pertains to identification number, measurement description, channel, data range, priority, response, and device location. Subheadings in the channel columns indicate the following: LK (link) designates the telemetry (r-f carrier) package A, B, or C; SC No. (subcarrier number) designates telemetry channels 1 through 18, and Com Seg (commutator segment) designates the telemetry commutator segment assigned to the measurement for that vehicle. LV TM (launch vehicle telemetry), which appears in the channel LK and SC No. columns, designates a measurement to be telemetered by launch vehicle telemetry. The data range columns denote minimum and maximum values for a parameter in engineering units. The following letters in the PR (priority) column indicate how critical the measurements are: P (primary) denotes measurements that must be available at launch for mission success and to meet the flight objectives; S (secondary) denotes measurements that are highly desirable, but will not abort or delay the mission if inoperative, and M (multiple) designates a group of measurements of which only a specified percentage may be inoperative. The response column denotes the rate and unit required to provide satisfactory data resolution to time or waveform. Response for continuous data monitoring (telemetry or recorder) is specified in cycles per second (cps), and sampled-data monitoring (PCM or PACE) is specified in samples per second (S/S). The location column refers to the coordinates which denote the physical location within the spacecraft where measurement is taken.

4-13. SIGNAL CONDITIONER. The signal conditioner adapts all signals received from the measurement sensors to the telemetry signal input requirements and also directs the conditioned signal to the proper telemetry system. All R and Z calibration command circuitry is included in the signal conditioner unit. Z (zero) is equal to 15 percent of full-scale signal and R (range) is equal to 85 percent of full-scale signal.

4-14. VIBRATION SENSORS. Spacecraft radial vibrations are monitored by six vibration transducers located in the command module (1), service module (3), and adapter (2). The sensor circuitry includes an amplifier which raises the signal to a level compatible with the required signal input of the signal conditioner. Two additional sensors and an acoustical device (microphone) are located on the service module surface to determine structural response and aerodynamic and engine noises during boost and staging phases. These signals are routed through the booster instrument unit.

4-15. STRAIN SENSORS. Four strain gages are mounted on the adapter stringer frame and two on the service module ring frame to determine spacecraft structural integrity under dynamic loads. The circuitry includes an amplifier which raises the signal to a level compatible with the required signal input of the signal conditioner.

4-16. PRESSURE TRANSDUCERS. There are 26 pressure-sensing devices located in the spacecraft as follows: one transducer in the command module and one in the service module. The transducers monitor static internal pressures. Nine conical surface pressure sensors are mounted about the command module exterior, to determine the aerodynamic effects on the spacecraft to verify stability and loads. Fifteen fluctuating pressure transducers are located on the spacecraft, two in the command module and eleven in the service

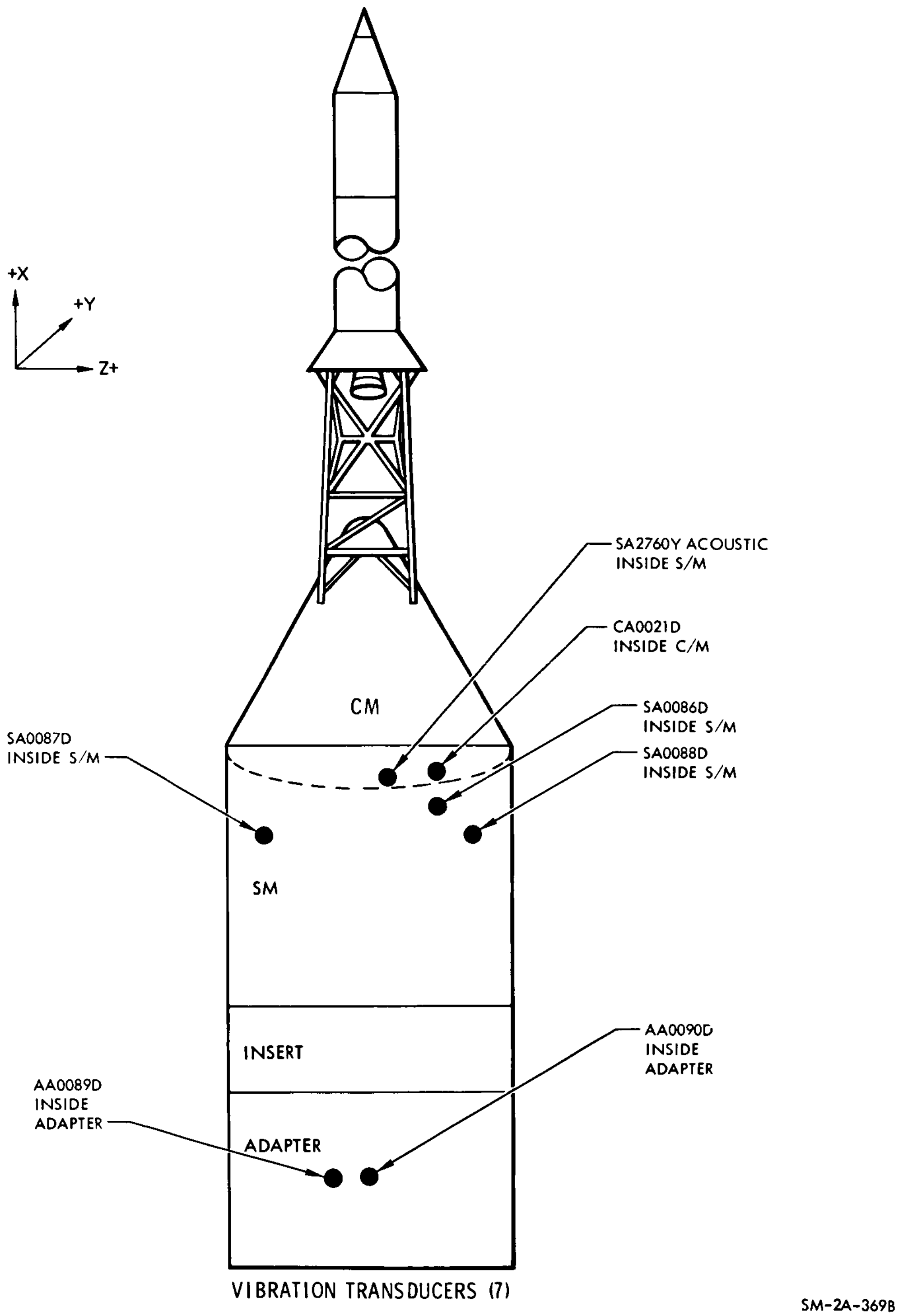


Figure 4-2. R&D Instrumentation Locations (Sheet 1 of 6)

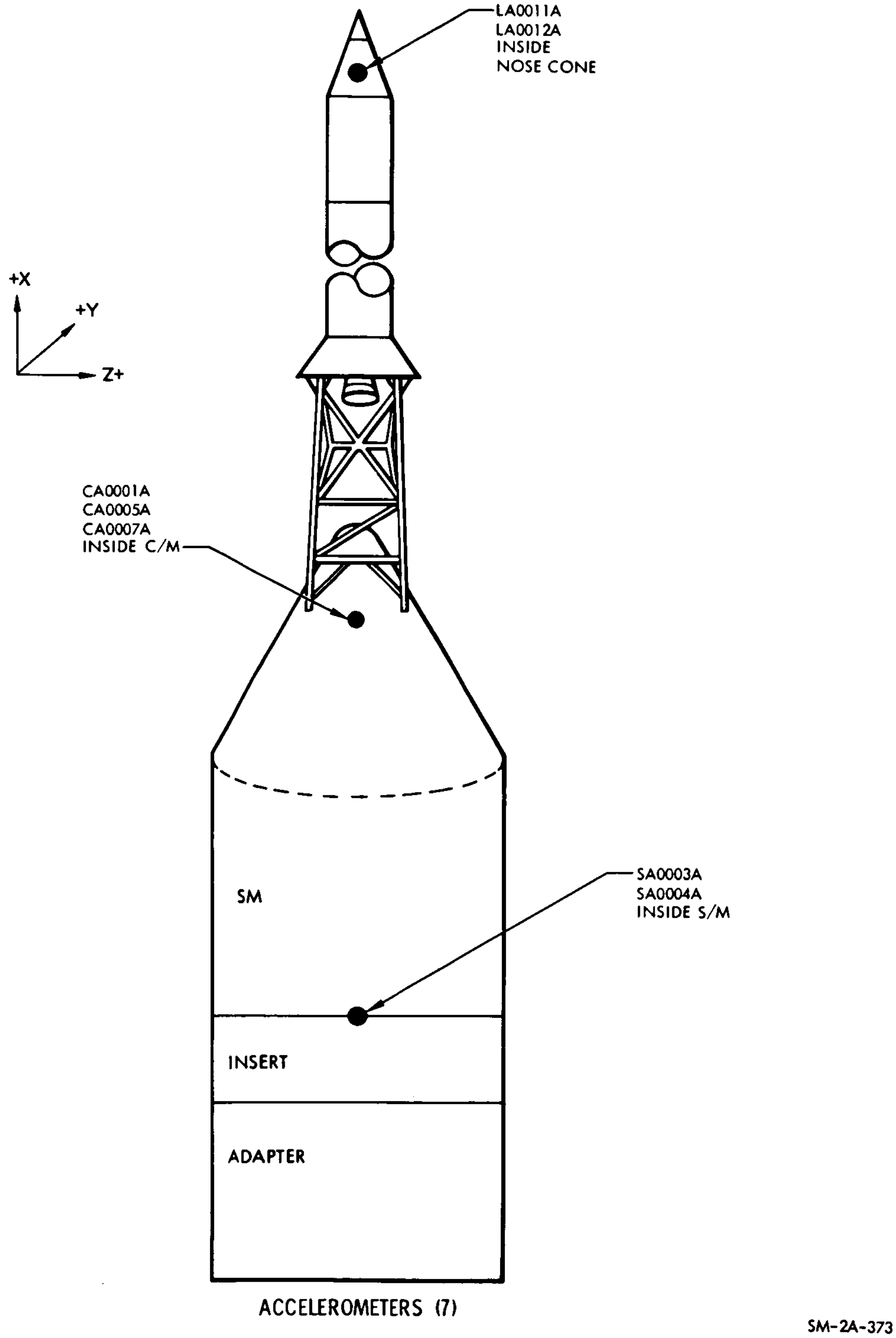


Figure 4-2. R&D Instrumentation Locations (Sheet 2 of 6)

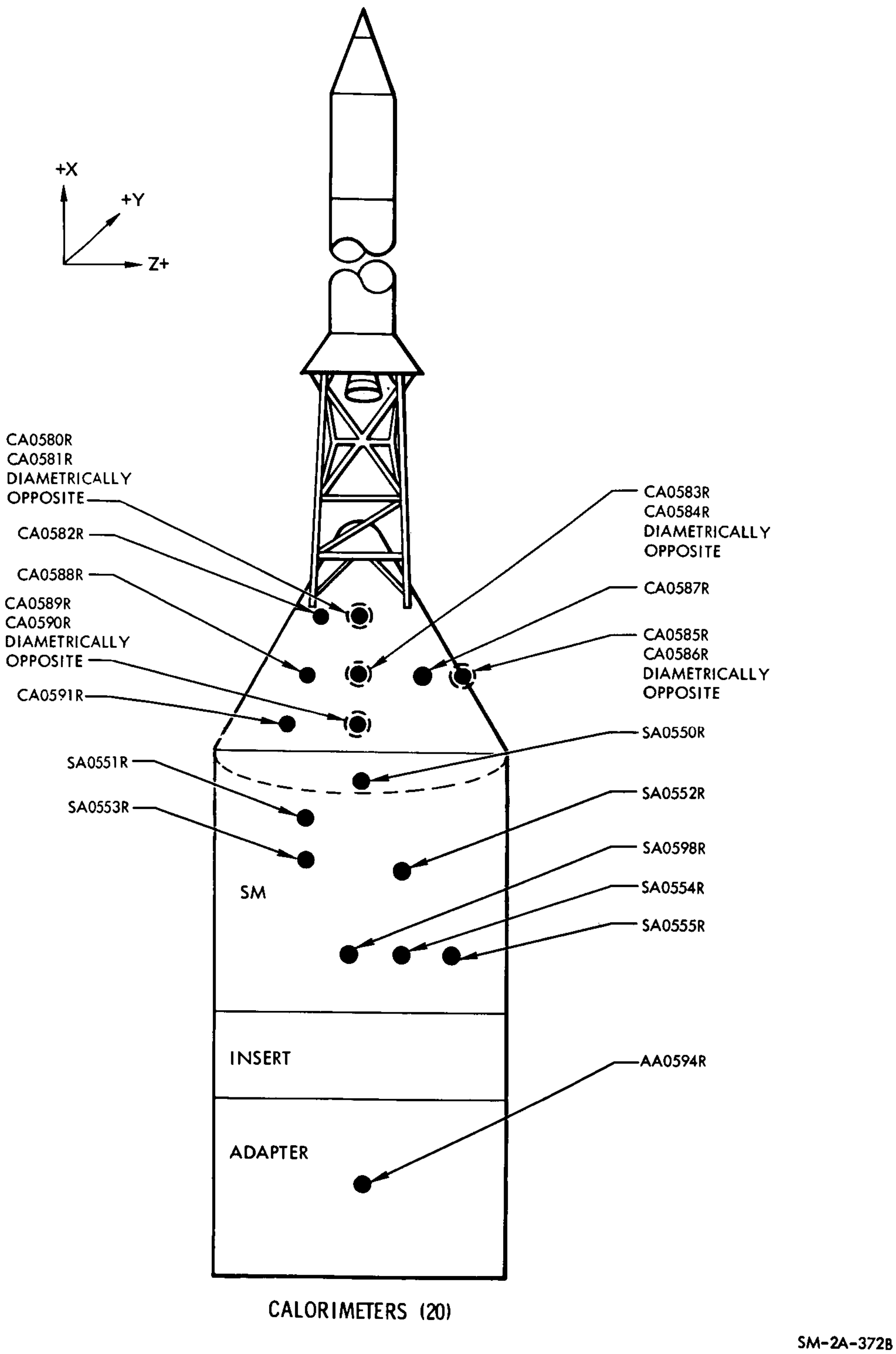
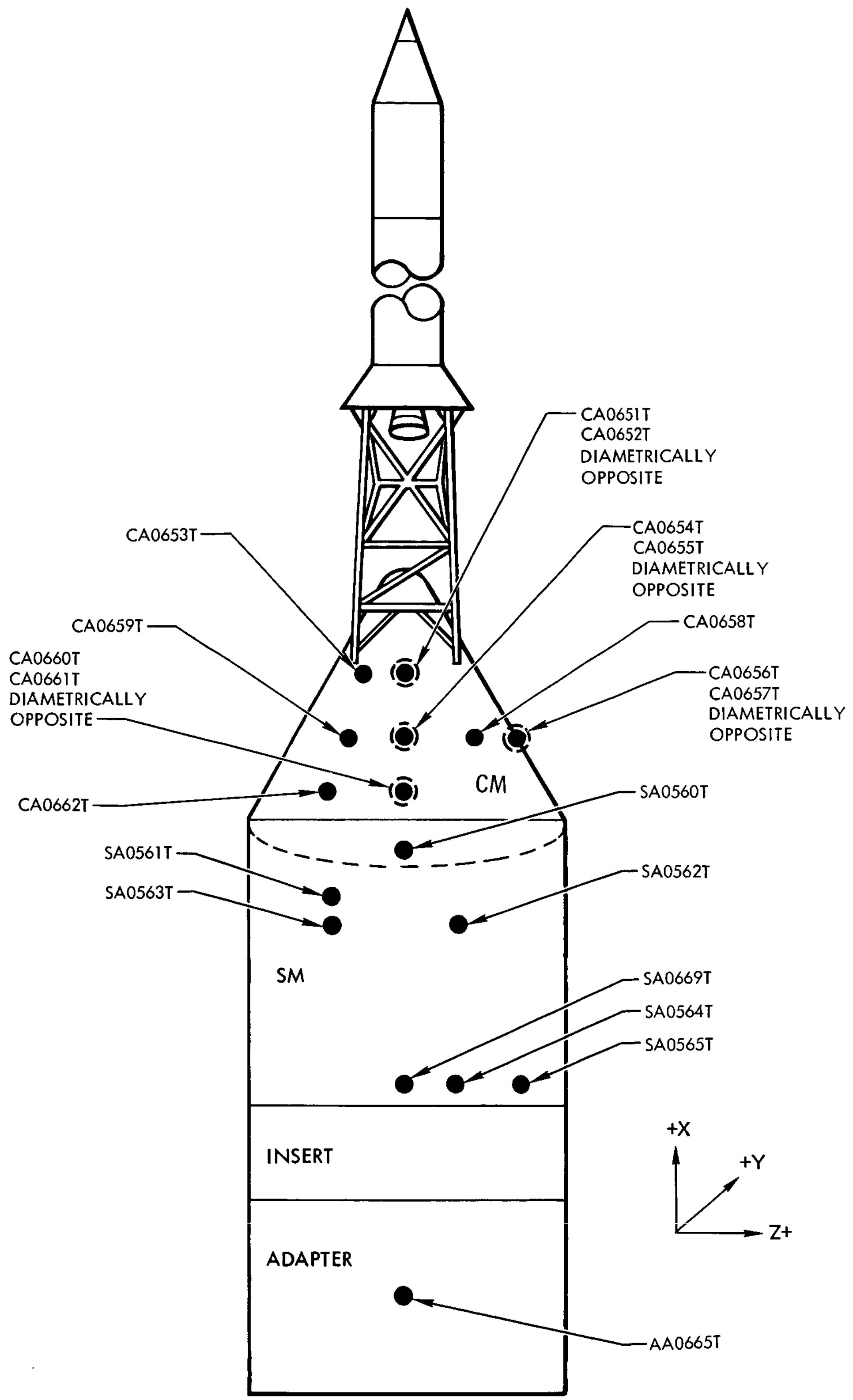
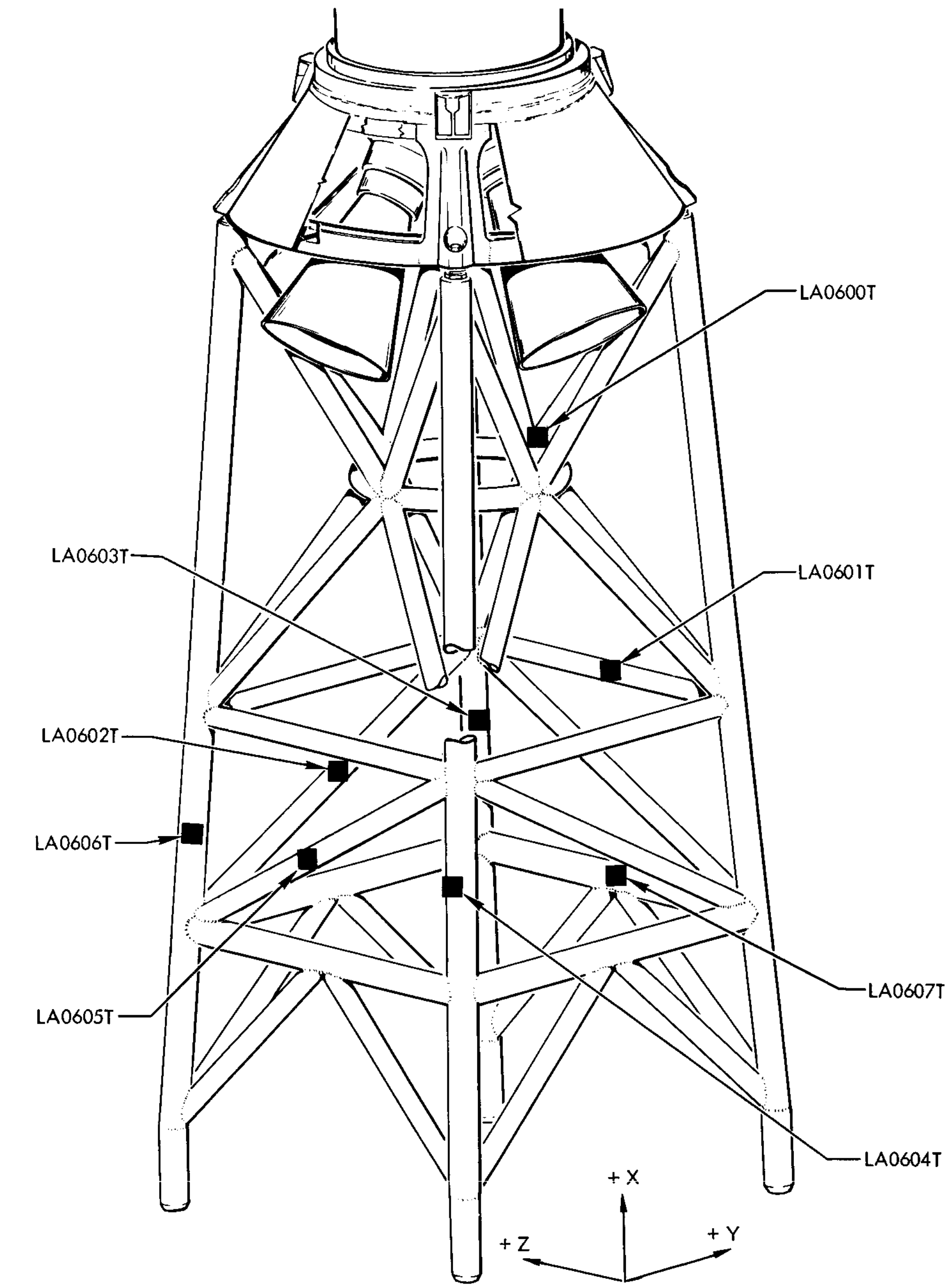


Figure 4-2. R&D Instrumentation Locations (Sheet 3 of 6)



CALORIMETER BODY TEMPERATURES (20)



TOWER TEMPERATURES (8)

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Figure 4-2. R&D Instrumentation Locations (Sheet 5 of 6)

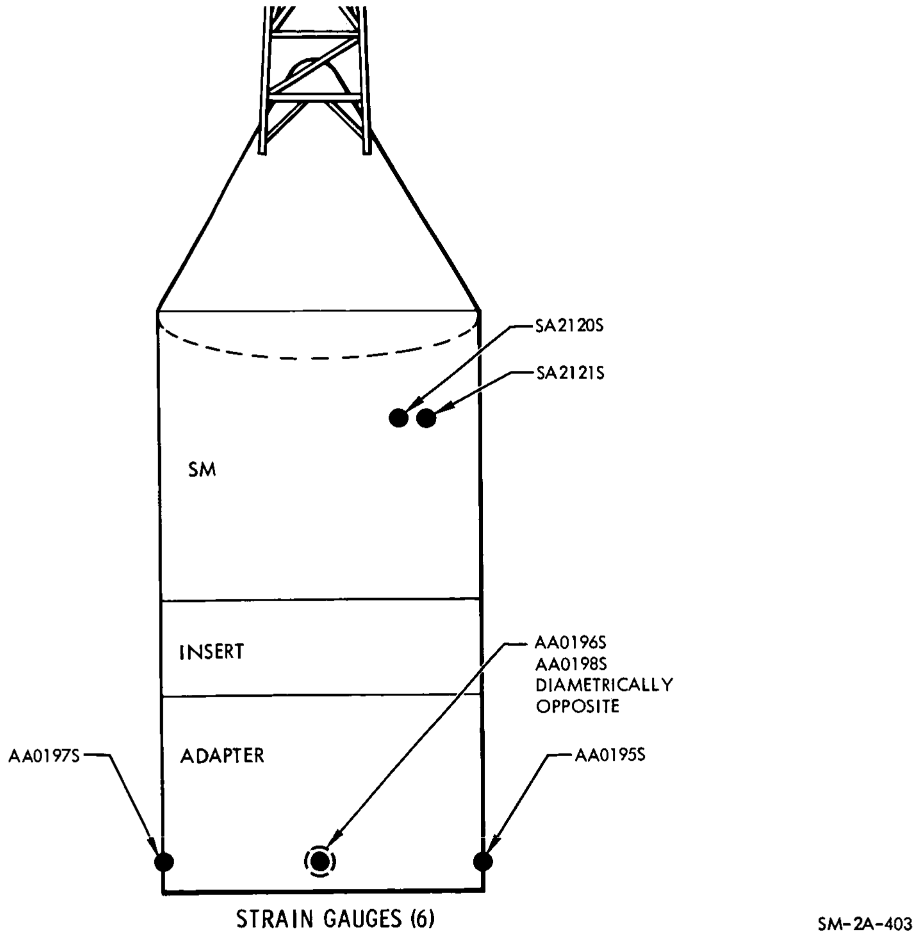

Figure 4-2. R&D Instrumentation Locations (Sheet 6 of 6)

module. These measurements help to define boundary layer noise, confirm environmental predictions, and determine sonic-induced vibration response of the service module panels.

4-17. ACCELEROMETERS. Spacecraft acceleration measurements in all three planes are required to determine flight parameters and tower structure flight loads. Two accelerometers are mounted in the nose cone of the launch escape motor. One is assembled to measure acceleration along the Y-axis and the other is assembled to measure acceleration along the Z-axis. Three accelerometers are mounted in the command module to measure acceleration in all three axes and two are mounted in the service module to measure accelerations along the Y- and Z-axes.

4-18. VOLTAGE DIVIDER NETWORKS. Two voltage divider networks provide the means to monitor the main bus d-c voltage. The voltage levels of the two logic and two pyro buses can also be monitored by means of the voltage divider networks. This also provides events sequence information as to the time of arming the buses. Other events, which are sensed through relay closure, are jettison motor ignition commands and resultant tower separation, and tower-command module separation command from the booster guidance system. The purpose of monitoring the voltage levels is to determine the electrical capability of the electrical power system and the mission sequencer during flight loading conditions. The purpose of the events signals is to demonstrate tower jettison sequencing.

4-19. Sensors are also provided to monitor the sequencer control S-I lift-off signal from the booster instrument unit and to monitor transponder trigger signals.

4-20. TEMPERATURE SENSORS. A temperature sensor is mounted in the interior of both the command module and service module to determine interior temperatures during flight loading conditions. Eight resistance thermometers are mounted on the launch escape system tower structure members to determine aerodynamic heating. A thermocouple is mounted on each calorimeter to sense calorimeter body temperature for use in computing heat flow from the data provided by the 20 calorimeters. Telemetry transmitter and r-f amplifier environmental temperatures are monitored for abnormal heating by six sensors mounted in the telemetry packages.

4-21. CALORIMETERS. Twenty calorimeters are located in the spacecraft to measure heating rates of various areas in order to adequately define aerodynamic heating of the spacecraft. Twelve are located about the command module surface, seven on the service module surface, and one on the adapter surface.

4-22. CURRENT SENSOR. A current sensor is located in the power control box. It monitors the total main power direct current flow during system operation to assist in determining the electrical capability and operation of the electrical power system.

4-23. Q-BALL. (See figures 4-3 and 4-4.) Three pressure transducers with associated electronics and wiring form the MSFC-furnished Q-ball system. Data acquired by the Q-ball includes angle of attack, angle of sideslip, and dynamic ram pressures. The transducers are located in the LES nose cone and sense airflow direction and pressure through ports in the nose cone surface. The input voltage is 28 volts dc. The transducers are capacitance-balanced with conversion of input power to 8 kilocycles. The output of the transducers is proportional to the three differential pressures measured. The transducer outputs are routed to the booster instrumentation unit control computer and conditioned for booster telemetry, but are not used functionally.

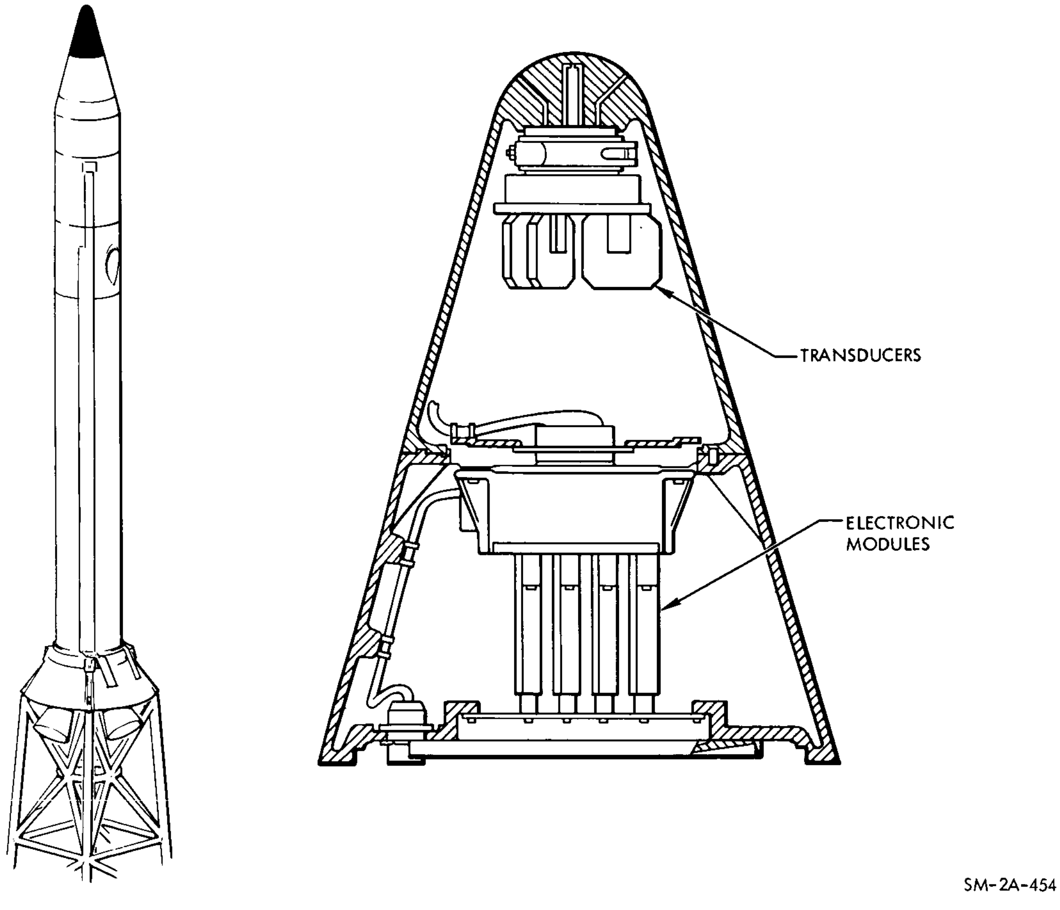

Figure 4-3. Q-Ball

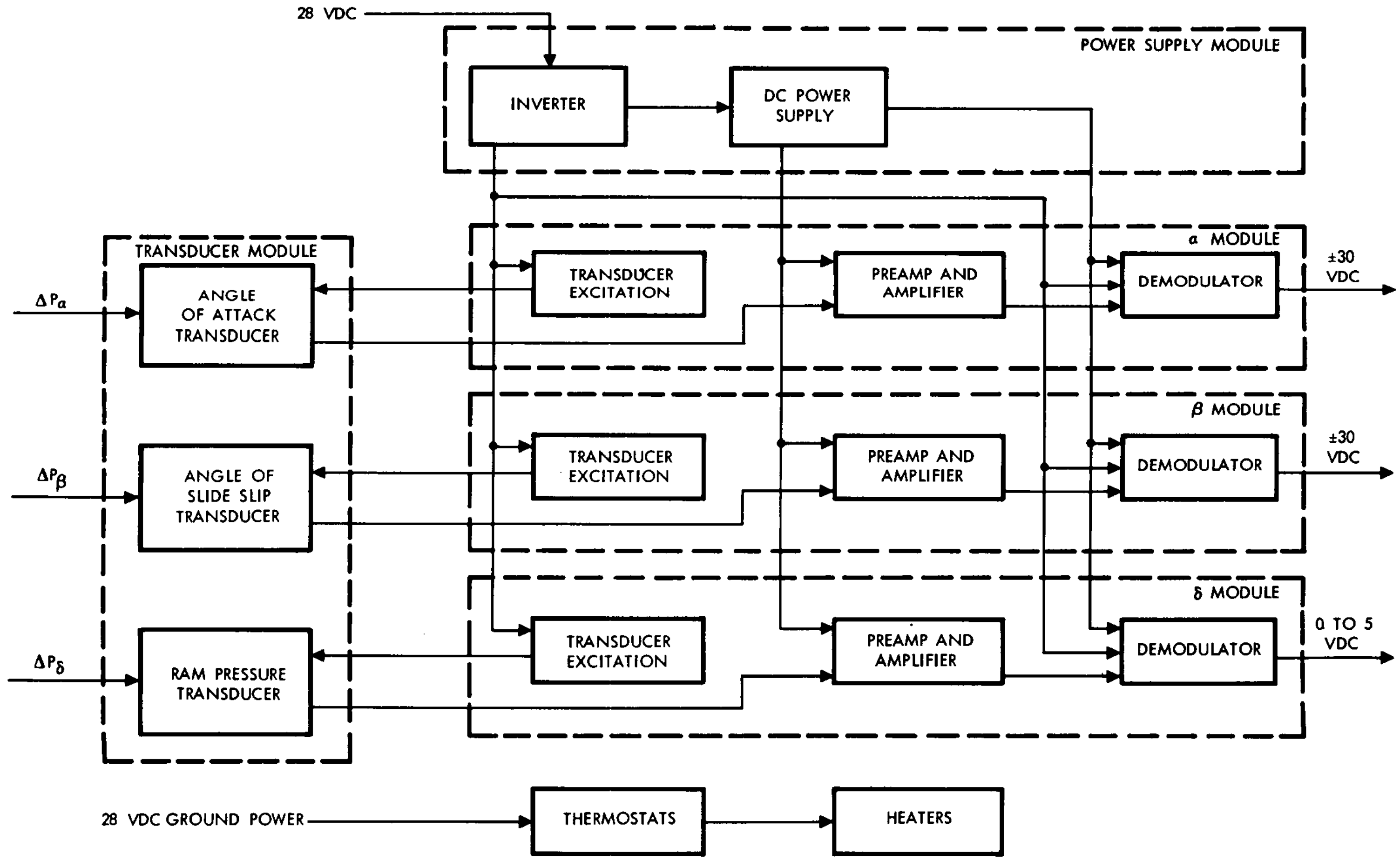

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Figure 4-4. Q-Ball Block Diagram

Table 4-1. Apollo CM/SM Measurement List

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
Structures											
CA0001A	X-axis spacecraft accel high	C	8		-2	+10	G	P	0-30	cps	XC78, YC0, ZC21
SA0003A	Z-axis spacecraft accel S/M	C	7		-0.5	+0.5	G	P	0-20	cps	XA866, YA0, ZA73
SA0004A	Y-axis spacecraft accel S/M	A	6		-0.5	+0.5	G	P	0-20	cps	XA866, YA0, ZA73
CA0005A	Y-axis spacecraft accel	C	6		-0.5	+0.5	G	P	0-20	cps	XC78, YC0, ZC21
CA0007A	Z-axis spacecraft accel	B	6		-0.5	+0.5	G	P	0-20	cps	XC78, YC0, ZC21
LA0011A	Y-axis tower accel	B	7		-2	+2	G	P	0-30	cps	XL380, YL0, ZL6
LA0012A	Z-axis tower accel	B	8		-2	+2	G	P	0-30	cps	XL380, YL6, ZL0
CA0021D	C/M radial vibration 1	A	16		-50	+50	G	P	20-1000	C	XC14, YC40.4 ZC37.3
CA0071P	Conical surface pressure 1	A	E	66	+0	+15	psia	M	10	S/S	XC76, 357 DEG
CA0072P	Conical surface pressure 2	A	E	67	+0	+15	psia	M	10	S/S	XC76, 87 DEG
CA0073P	Conical surface pressure 3	A	E	68	+0	+15	psia	M	10	S/S	SC36, 357 DEG

Table 4-1. Apollo CM/SM Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
Structures											
CA0074P	Conical surface pressure 4	A	E	69	+0	+15	psia	M	10	S/S	XC36, 93 DEG
CA0075P	Conical surface pressure 5	A	E	70	+0	+15	psia	M	10	S/S	XC29, 180 DEG
CA0076P	Conical surface pressure 6	A	E	71	+0	+15	psia	M	10	S/S	XC27, 357 DEG
CA0077P	Conical surface pressure 7	A	E	72	+0	+15	psia	M	10	S/S	XC27, 87 DEG
CA0078P	Conical surface pressure 8	A	E	73	+0	+15	psia	M	10	S/S	XC20, 357 DEG
CA0079P	Conical surface pressure 9	A	E	74	+0	+15	psia	M	10	S/S	XC20, 180 DEG
SA0086D	S/M radial vibration 2	C	18		-50	+50	G	P	20-1000	C	XA965.2, YA42.8, ZA58
SA0087D	S/M radial vibration 3	C	17		-50	+50	G	P	20-1000	C	XA953, YA53.9, ZA47.7
SA0088D	S/M radial vibration 4	B	17		-50	+50	G	P	20-1000	C	XA940.4, YA-68.3, ZA22.8
AA0089D	Adapter radial vibration 5	LV	TM		-50	+50	G	P	25-2000	C	XA777.7, YA0, ZA72
AA0090D	Adapter radial vibration 6	LV	TM		-50	+50	G	P	25-2000	C	XA777.7, YA-15.5, ZA71

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CA0160P	Fluctuating pressure 1	B	18	+0	+15	psia	M	1000	cps	XC70, 357 DEG
CA0161P	Fluctuating pressure 2	B	15	+0	+15	psia	M	300	cps	XC40.4, 180 DEG
SA0162P	Fluctuating pressure 3	A	15	+0	+15	psia	M	300	cps	XA1000, 329.25 DEG
SA0163P	Fluctuating pressure 4	C	14	+0	+15	psia	M	300	cps	XA959, 24.1 DEG
SA0164P	Fluctuating pressure 5	A	14	+0	+15	psia	M	300	cps	XA959, 58.9 DEG
SA0165P	Fluctuating pressure 6	B	14	+0	+15	psia	M	300	cps	XA973, 277.5 DEG
SA0166P	Fluctuating pressure 7	C	13	+0	+15	psia	M	300	cps	XA959, 215.3 DEG
SA0167P	Fluctuating pressure 8	C	15	+0	+15	psia	M	300	cps	XA938, 147.9 DEG
SA0168P	Fluctuating pressure 9	B	12	+0	+15	psia	M	300	cps	XA932, 187.25 DEG
SA0169P	Fluctuating pressure 10	A	11	+0	+15	psia	M	300	cps	XA919, 58.9 DEG
SA0170P	Fluctuating pressure 11	A	12	+0	+15	psia	M	300	cps	XC893.5, 316.6 DEG
SA0171P	Fluctuating pressure 12	A	13	+0	+15	psia	M	300	cps	XA906, 277.25 DEG
SA0172P	Fluctuating pressure 13	C	11	+0	+15	psia	M	300	cps	XA881, 277.25 DEG
SA0173P	Fluctuating pressure 14	C	12	+0	+15	psia	M	300	cps	XA764, 183 DEG
SA0174P	Fluctuating pressure 15	B	11	+0	+15	psia	M	300	cps	XA737, 3 DEG
AA0195S	Strain 1 adapter	A	9	-1000	+1000	UI/IN	M	100	cps	XA736, YA76, ZA0
AA0196S	Strain 2 adapter	A	10	-1000	+1000	UI/IN	M	100	cps	XA736, YA0, ZA76
AA0197S	Strain 3 adapter	B	10	-1000	+1000	UI/IN	M	100	cps	XA736, YA76, ZA0
AA0198S	Strain 4 adapter	C	10	-1000	+1000	UI/IN	M	100	cps	XA736, YA0, ZA76

Table 4-1. Apollo CM/SM Measurment List (Cont)

Meas. ID	Measurement Description	Channel			Data Range			PR	Response		Location
		L K	SC No.	Com Seg	Low	High	Unit		Rate	Unit	
					Structures						
SA0550R	Heat flux (calorimeter) 17	B	13	28	+0	+5	B/F/S	M	1.25	S/S	XS338, 183 DEG
SA0551R	Heat flux (calorimeter) 18	B	13	29	+0	+5	B/F/S	M	1.25	S/S	XS315, 187.2 DEG
SA0552R	Heat flux (calorimeter) 20	B	13	31	+0	+5	B/F/S	M	1.25	S/S	XS305, 177 DEG
SA0553R	Heat flux (calorimeter) 13	B	13	24	+0	+5	B/F/S	M	1.25	S/S	XS305, 187.2 DEG
SA0554R	Heat flux (calorimeter) 14	B	13	25	+0	+5	B/F/S	M	1.25	S/S	XS267, 160 DEG
SA0555R	Heat flux (calorimeter) 16	B	13	27	+0	+5	B/F/S	M	1.25	S/S	XS267, 145 DEG
SA0560T	Calorimeter body temp 17	B	13	48	+0	+300	Deg C	S	1.25	S/S	XS338, 183 DEG
SA0561T	Calorimeter body temp 18	B	13	49	+0	+300	Deg C	S	1.25	S/S	XS315, 187.2 DEG
SA0562T	Calorimeter body temp 20	B	13	51	+0	+300	Deg C	S	1.25	S/S	XS305, 177 DEG
SA0563T	Calorimeter body temp 13	B	13	44	+0	+300	Deg C	S	1.25	S/S	XS305, 187.2 DEG
SA0564T	Calorimeter body temp 14	B	13	45	+0	+300	Deg C	S	1.25	S/S	XS267, 160 DEG

SA0565T	Calorimeter body temp 16	B	13	47	+0	+300	Deg C	S	1.25	S/S	XS267, 145 DEG
CA0580R	Heat flux (calorimeter) 1	B	13	12	+0	+25	B/F/S	M	1.25	S/S	XC74, 3 DEG
CA0581R	Heat flux (calorimeter) 2	B	13	13	+0	+25	B/F/S	M	1.25	S/S	XC74, 180 DEG
CA0582R	Heat flux (calorimeter) 3	B	13	14	+0	+25	B/F/S	M	1.25	S/S	XC74, 319 DEG
CA0583R	Heat flux (calorimeter) 4	B	13	15	+0	+25	B/F/S	M	1.25	S/S	XC53, 180 DEG
CA0584R	Heat flux (calorimeter) 5	B	13	16	+0	+25	B/F/S	M	1.25	S/S	XC52, 3 DEG
CA0585R	Heat flux (calorimeter) 6	B	13	17	+0	+25	B/F/S	M	1.25	S/S	XC52, 80 DEG
CA0586R	Heat flux (calorimeter) 7	B	13	18	+0	+25	B/F/S	M	1.25	S/S	XC52, 85 DEG
CA0587R	Heat flux (calorimeter) 8	B	13	19	+0	+25	B/F/S	M	1.25	S/S	XC52, 95 DEG
CA0588R	Heat flux (calorimeter) 9	B	13	20	+0	+25	B/F/S	M	1.25	S/S	XC52, 319 DEG
CA0589R	Heat flux (calorimeter) 10	B	13	21	+0	+25	B/F/S	M	1.25	S/S	XC42.65, 3 DEG
CA0590R	Heat flux (calorimeter) 11	B	13	22	+0	+25	B/F/S	M	1.25	S/S	XC27, 180 DEG
CA0591R	Heat flux (calorimeter) 12	B	13	23	+0	+25	B/F/S	M	1.25	S/S	XC27, 319 DEG
AA0594R	Heat flux (calorimeter) 19	B	13	30	+0	+5	B/F/S	M	1.25	S/S	XA770, 183 DEG
SA0598R	Heat flux (calorimeter) 15	B	13	26	+0	+5	B/F/S	M	1.25	S/S	XA933, 183 DEG
LA0600T	Tower temperature 1	B	13	52	+0	+150	Deg C	M	1.25	S/S	XL90, YL12, ZL0
LA0601T	Tower temperature 2	B	13	53	+0	+150	Deg C	M	1.25	S/S	XL61, YL22, ZL0
LA0602T	Tower temperature 3	B	13	54	+0	+150	Deg C	M	1.25	S/S	XL47, YL0, ZL23

Table 4-1. Apollo CM/SM Measurement List (Cont)

Meas. ID	Measurement Description	Channel			Data Range			PR	Response		Location
		L K	SC No.	Com Seg	Low	High	Unit		Rate	Unit	
Structures											
LA0603T	Tower temperature 4	B	13	55	+0	+150	Deg C	M	1.25	S/S	XL47, YL24, ZL23
LA0604T	Tower temperature 5	B	13	56	+0	+150	Deg C	M	1.25	S/S	XL47, YL24, ZL23
LA0605T	Tower temperature 6	B	13	57	+0	+150	Deg C	M	1.25	S/S	XL47, YL24, ZL0
LA0606T	Tower temperature 7	B	13	58	+0	+150	Deg C	M	1.25	S/S	XL47, YL24, ZL23
LA0607T	Tower temperature 8	B	13	59	+0	+150	Deg C	M	1.25	S/S	XL36, YL24, ZL0
CA0610T	C/M interior temp	B	13	4	+0	+150	Deg C	S	1.25	S/S	C/M interior
CA0611P	C/M interior press	A	E	88	+0	+15	psia	S	10	S/S	C/M interior
SA0612T	S/M interior temp	B	13	5	+0	+150	Deg C	S	1.25	S/S	S/M interior
SA0613P	S/M interior press	A	E	87	+0	+15	psia	S	10	S/S	S/M interior
CA0651T	Calorimeter body temp 1	B	13	32	+0	+300	Deg C	S	1.25	S/S	XC74, 3 DEG
CA0652T	Calorimeter body temp 2	B	13	33	+0	+300	Deg C	S	1.25	S/S	XC74, 180 DEG
CA0653T	Calorimeter body temp 3	B	13	34	+0	+300	Deg C	S	1.25	S/S	XC74, 319 DEG
CA0654T	Calorimeter body temp 4	B	13	35	+0	+300	Deg C	S	1.25	S/S	XC53, 180 DEG
CA0655T	Calorimeter body temp 5	B	13	36	+0	+300	Deg C	S	1.25	S/S	XC52, 3 DEG

CA0656T	Calorimeter body temp 6	B	13	37	+0	+300	Deg C	S	1.25	S/S	XC52, 80 DEG
CA0657T	Calorimeter body temp 7	B	13	38	+0	+300	Deg C	S	1.25	S/S	XC52, 85 DEG
CA0658T	Calorimeter body temp 8	B	13	39	+0	+300	Deg C	S	1.25	S/S	XC52, 95 DEG
CA0659T	Calorimeter body temp 9	B	13	40	+0	+300	Deg C	S	1.25	S/S	XC52, 319 DEG
CA0660T	Calorimeter body temp 10	B	13	41	+0	+300	Deg C	S	1.25	S/S	XC42.65, 3 DEG
CA0661T	Calorimeter body temp 11	B	13	42	+0	+300	Deg C	S	1.25	S/S	XC27, 180 DEG
CA0662T	Calorimeter body temp 12	B	13	43	+0	+300	Deg C	S	1.25	S/S	XC27, 319 DEG
AA0665T	Calorimeter body temp 19	B	13	50	+0	+300	Deg C	S	1.25	S/S	XA770, 183 DEG
SA0669T	Calorimeter body temp 15	B	13	46	+0	+300	Deg C	S	1.25	S/S	XA933, 183 DEG
SA2120S	Strain 1 service module	C	16		-4000	+4000	UI/IN	M	250	cps	XA940.4, 62.25 DEG
SA2121S	Strain 2 service module	B	16		-4000	+4000	UI/IN	M	250	cps	XA940.4, 77.25 DEG
SA2760Y	Service module acoustic	LV	TM		+150	+170	DB	S	25-3000	C	XS339, 0 DEG
					Electrical						
CC0001V	D-C voltage main bus A	A	E	24	+22	+32	VDC	P	10	S/S	Pwr control box
CC0002V	D-C voltage main bus B	A	E	25	+22	+32	VDC	P	10	S/S	Pwr control box

Table 4-1. Apollo CM/SM Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
					Electrical						
CC0003V	D-C voltage logic bus A	A	E	22	+0	+36	VDC	P	10	S/S	LES sequencer
CC0004V	D-C voltage logic bus B	A	E	23	+0	+36	VDC	P	10	S/S	LES sequencer
CC0005C	Total D-C current	A	E	26	+0	+50	AMPS	P	10	S/S	Pwr control box
					Launch Escape						
BD0001X	S-I lift-off signal	A9	A10				Step	M	100	cps	Sig cond box
LD0033X	Twr jett and sep relay close A	A	E	29			Step	P	10	S/S	Twr LES sequencer
LD0034X	Twr jett and sep relay close B	A	E	29			Step	P	10	S/S	Twr LES sequencer
CD0039V	Twr jett sep signal A	A	E	37	+0	+36	VDC	P	10	S/S	LES sequencer
CD0040V	Twr jett sep signal B	A	E	38	+0	+36	VDC	P	10	S/S	LES sequencer
CD0185V	D-C voltage twr pyro bus A	A	E	28	+0	+36	VDC	P	10	S/S	LES sequencer
CD0186V	D-C voltage twr pyro bus B	A	E	35	+0	+36	VDC	P	10	S/S	LES sequencer
					Communications and Instrumentation						
CT0002V	Transponder A trigger	A	E	57	+0	+5	VDC	S	10	S/S	Transponder A
CT0003V	Transponder B trigger	A	E	58	+0	+5	VDC	S	10	S/S	Transponder B
CT0007X	R&Z calibration monitor	A	E	59			STEP	P	10	S/S	Sig cond box
CT0201T	TM RF XMTR A temp	B	13	6	+0	+150	Deg C	S	1.25	S/S	TM RF XMTR A
CT0202T	TM RF AMP A temp	B	13	7	+0	+150	Deg C	S	1.25	S/S	TM RF AMP A

CT0203T	TM RF XMTR B temp	B	13	8	+0	+150	Deg C	S	1.25	S/S	TM RF XMTR B
CT0204T	TM RF AMP B temp	B	13	9	+0	+150	Deg C	S	1.25	S/S	TM RF AMP B
CT0205T	TM RF XMTR C temp	B	13	10	+0	+150	Deg C	S	1.25	S/S	TM RF XMTR C
CT0207T	TM RF AMP C temp	B	13	11	+0	+150	Deg C	S	1.25	S/S	TM RF AMP C
Environmental Control System											
CF0400T	R/D ECS CM interior temp	GSE			+0	+150	Deg F				CM interior
CF0401T	R/D ECS coldplate inlet temp	GSE			+0	+100	Deg F				Coldplate inlet
CF0402T	R/D ECS coldplate outlet temp	GSE			+0	+100	Deg F				Coldplate outlet
CF0403P	R/D ECS tank inlet press	GSE			+0	+50	PSID				Cool tank inlet
CF0404T	R/D ECS tank outlet temp	GSE			+0	+100	Deg F				Cool tank outlet
CF0405P	R/D ECS pump outlet press	GSE			+0	+50	PSID				Cool pump outlet

SECTION V

EQUIPMENT COOLING SYSTEM

5-1. PURPOSE.

5-2. The equipment cooling system is a specially designed water-glycol system which provides a coolant for five coldplates (three telemetry r-f packages and two C-band transponders). It also provides a continuous flow of air in the crew compartment for compartment cooling during ground operations and during the initial boost phase of the flight.

5-3. SYSTEM DESCRIPTION. (See figure 5-1.)

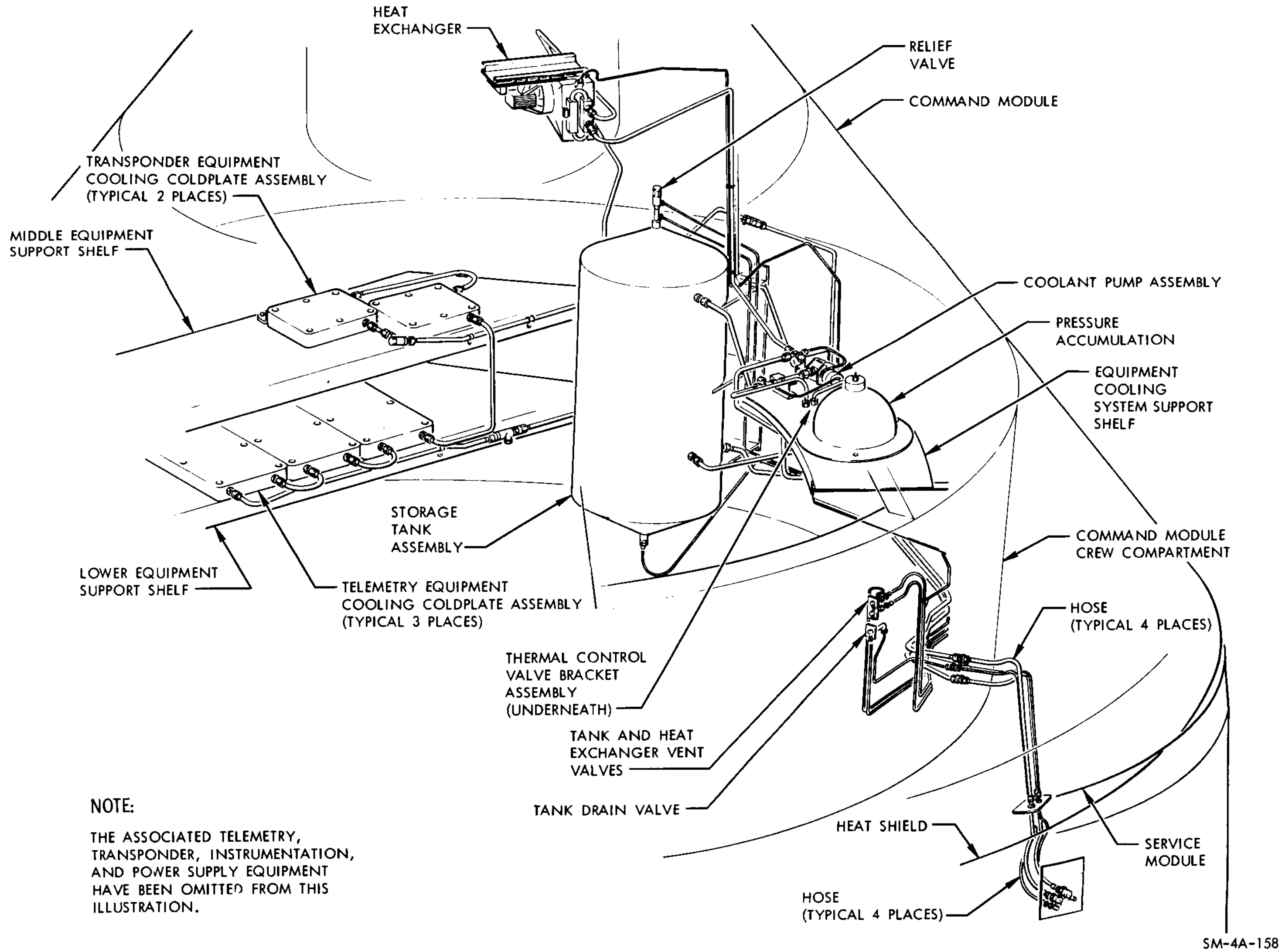
5-4. The complete cooling system for boilerplate 15 is located in the command module. The major components of the system are the supply tank, coolant pump, coldplates, heat exchanger with fan, accumulator, thermal control valve, and temperature and pressure transducers.

5-5. PRINCIPLES OF OPERATION. (See figure 5-2.)

5-6. OPERATION DURING MISSION. Coolant flow through the equipment cooling system is maintained by the pump assembly. The 250-pound capacity water-glycol tank operates in a standby condition to supply low-temperature coolant, when required, through the thermal control valve into the instrumentation cooling system. The thermal control valve is an automatic bypass valve which regulates the flow of coolant out of the tank into the closed cooling circuit. The thermal control valve is set to control the system temperature at 40±5°F for any inlet temperature encountered during the mission. The coolant continues from the thermal control valve to the coldplates of modulation packages A, B, and C and C-band transponders 1 and 2. The coldplates are connected in series. The heat exchanger receives the fluid from the coldplates and removes the ambient air heat load given off by the R&D instruments. Ambient air is circulated by the fan around the coiled tubing of the heat exchanger for crew compartment cooling.

5-7. Electrical power for equipment cooling system operation is supplied by the main batteries. Power from the batteries is routed through relay contacts to bus B in the power control box. Power from bus B is routed through relay contacts and fuses to a three-phase inverter and to two series-connected baroswitches. The three-phase inverter supplies power to operate the three-phase water-glycol pump motor. Power through the two baroswitches operate the heat exchanger control and the single-phase inverter which powers the fan motor. At a command module cabin pressure of 5 psi, the two baroswitches open, shutting down operation of the heat exchanger control, single-phase inverter, and fan motor. (See figure 5-3 for electrical schematic.)

5-8. OPERATION ON THE LAUNCH PAD. Ground support equipment furnishes water-glycol at 20°F to the spacecraft umbilical disconnect. The coolant flows into the tank continually, exciting the fluid in the tank, and flows out, returning to the GSE. The supply line and return line to the ground support equipment is disconnected by an umbilical disconnect on the service module. Pressure transducers are installed between the pump outlet and the thermal control valve, and between the glycol tank inlet and the GSE supply umbilical disconnect for checking system pressure. Temperature sensors are installed in the lines at the inlet side of the modulation package coldplates, at the inlet side of the heat exchanger, andat the outlet side of the glycol tank. This instrumentation is provided for ground monitoring only.



NOTE:

THE ASSOCIATED TELEMETRY, TRANSPONDER, INSTRUMENTATION, AND POWER SUPPLY EQUIPMENT HAVE BEEN OMITTED FROM THIS ILLUSTRATION.

Figure 5-1. Equipment Cooling System

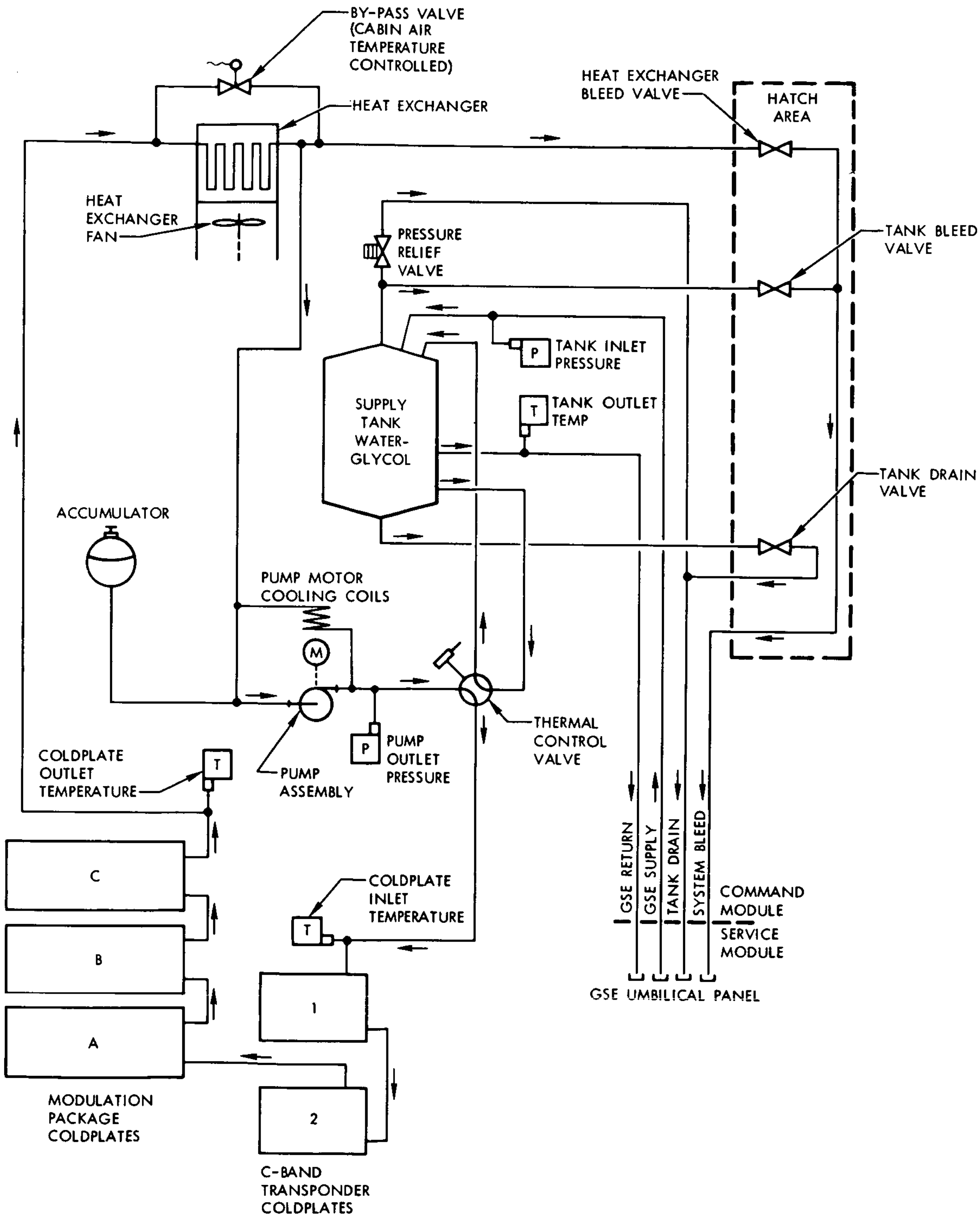


Figure 5-2. Equipment Cooling System Functional Diagram

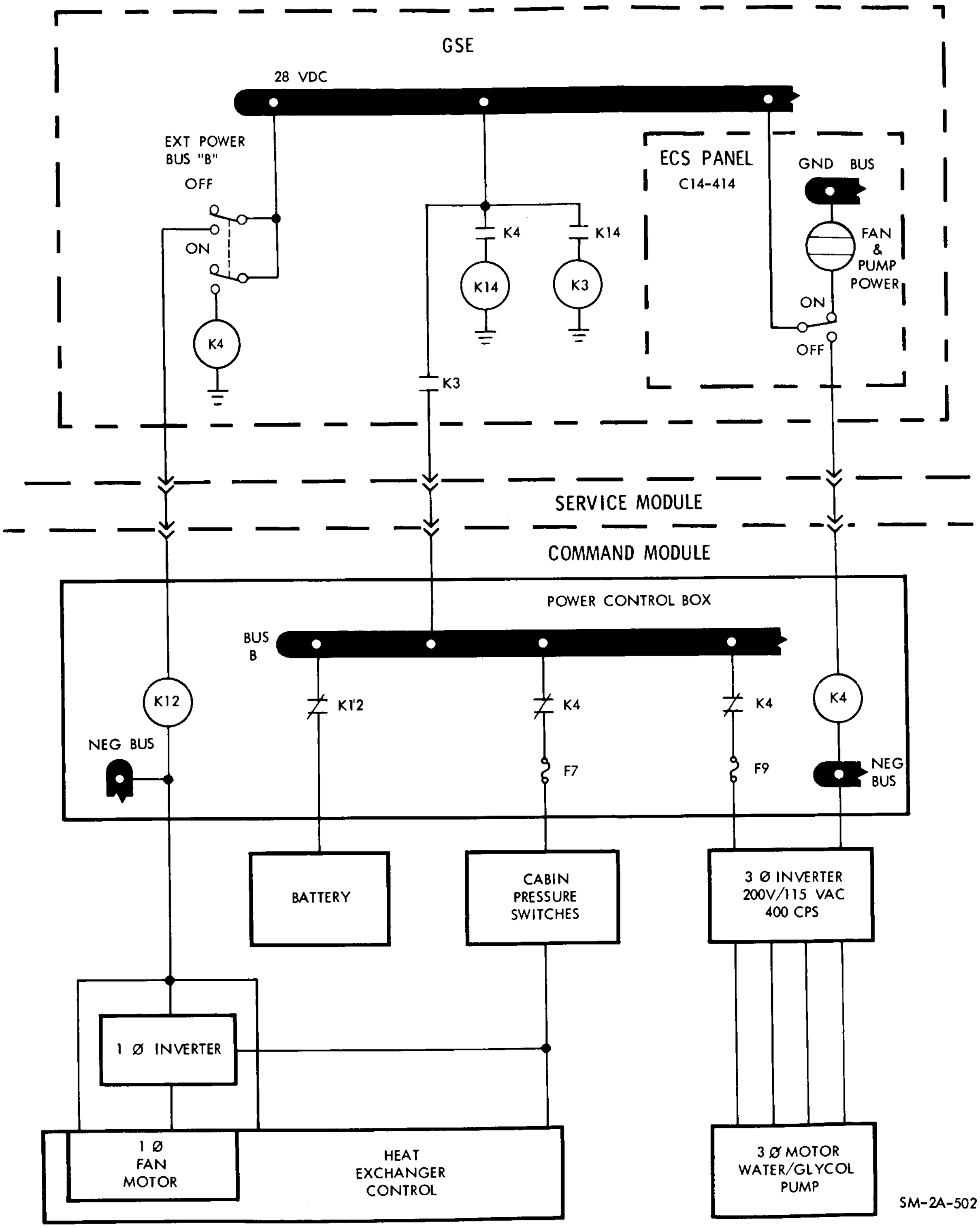


Figure 5-3. Equipment Cooling System Simplified Electrical Schematic (Sheet 1 of 2)

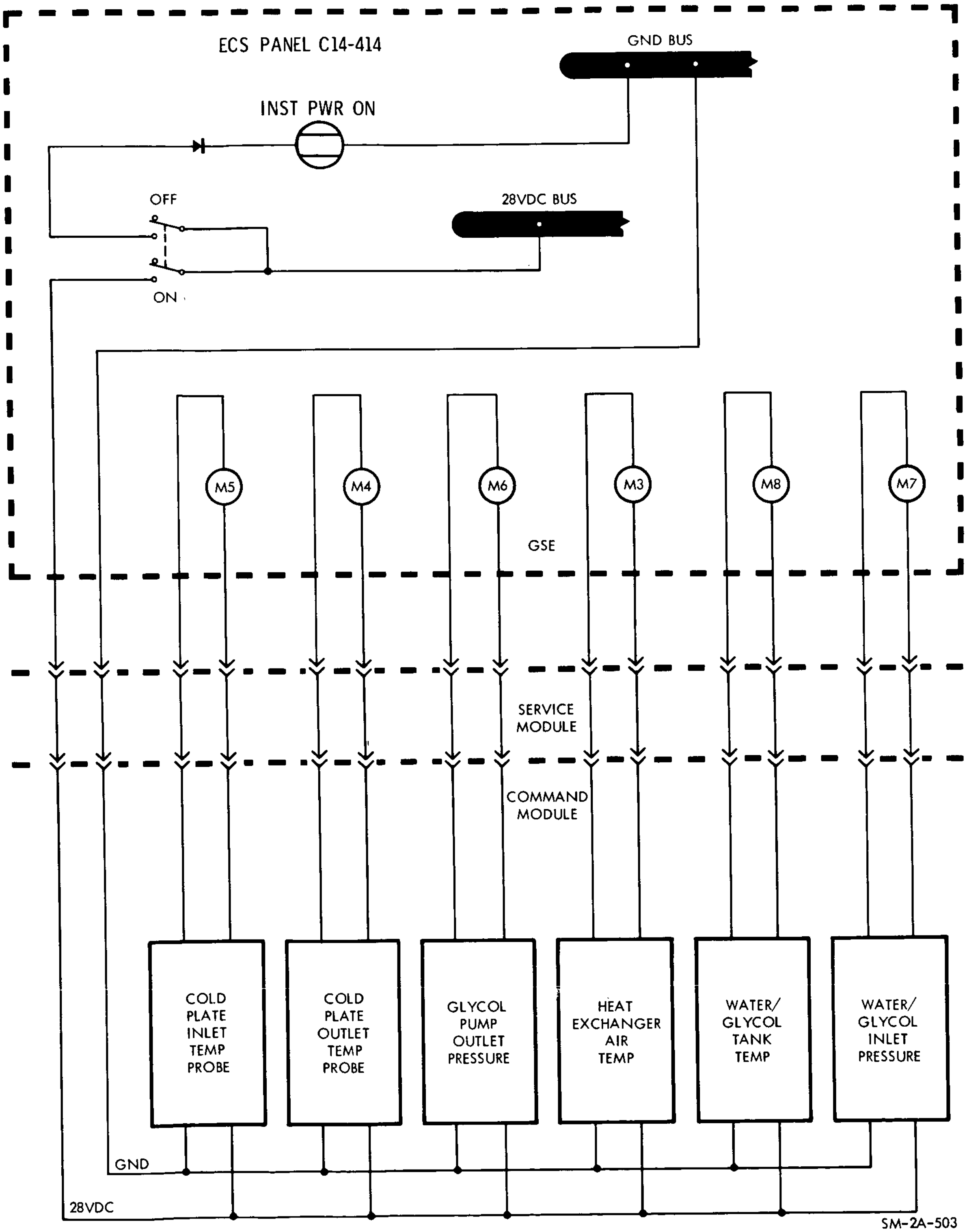


Figure 5-3. Equipment Cooling System Simplified Electrical Schematic (Sheet 2 of 2)

SECTION VI

ELECTRICAL POWER SYSTEM

6-1. PURPOSE.

6-2. The electrical power system supplies the power to the environmental control system and to all operational units of the communications and instrumentation system for switching and distribution of events that occur during a mission. It also provides the switching arrangement for event distribution to the signal conditioning unit and operating and monitoring power for launch escape system functions.

6-3. SYSTEM EQUIPMENT.

6-4. The electrical power system consists of six multi-cell, zinc-silver oxide batteries, a power control box, a junction box, and associated wire harnesses. These units are located on the equipment racks of the command module. Physical characteristics of the batteries are listed in table 6-1.

6-5. PRINCIPLES OF OPERATION. (See figure 6-1.)

6-6. The main batteries (NASA-furnished) provide the electrical power required to energize the instrumentation devices such as sensors, amplifiers, and telemetry equipment. The main batteries supply power to buses A and B of the power control box through normally closed contacts of the internal A and B power control relays. These relays can only be energized by GSE action. The power control relays remain open when power is being supplied by GSE to preserve the battery power prior to umbilical disconnect. Power transfer is accomplished manually. When power from GSE is discontinued, the power control relays close and system power is supplied by the on-board batteries.

6-7. The pyro batteries provide the electrical power to energize the tower separation system components. Redundant circuits provide the high reliability required to assure a successful mission.

6-8. The logic batteries provide the electrical power to energize control circuitry of the mission and tower sequencers. Redundant circuits provide the high reliability required to assure a successful mission.

6-9. POWER CONSUMPTION.

6-10. Optimum power requirements by system are as follows:

Equipment cooling system	396 watts (mission)
Communications and instrumentation system	924 watts (mission)
Launch escape system	
Tower jettison motor squibs	18 watts (for 20 milliseconds)
Tower leg separation squibs	72 watts (for 20 milliseconds).

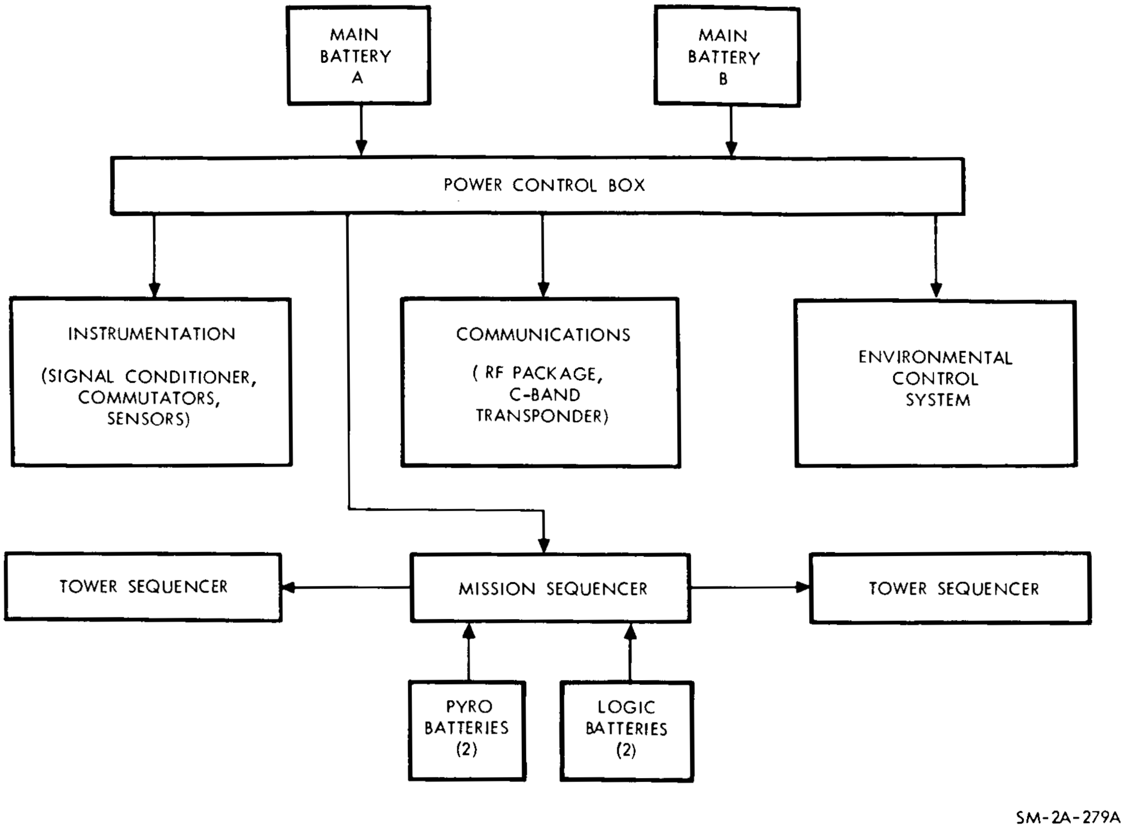


Figure 6-1. Electrical Power System Block Diagram

Table 6-1. Battery Physical Characteristics

Main batteries (instrumentation)	
Height	9.50 inches
Width	6.36 inches
Length	9.05 inches
Weight	52 pounds
Nominal voltage	28 volts
Capacity	120-ampere hours
Electrolyte	Potassium hydroxide.
Pyro and logic batteries	
Height	3.52 inches
Width	4.69 inches
Length	7.00 inches
Weight	7.6 pounds
Nominal voltage	28 volts
Capacity	5-ampere hours
Electrolyte	Potassium hydroxide.

SECTION VII

DOCUMENTATION AND SUPPORTING EQUIPMENT

7-1. PURPOSE.

7-2. This section contains a list of documentation (table 7-1) and lists ground support equipment (table 7-2) for boilerplate 15.

7-3. DOCUMENTATION.

7-4. Documents containing supplementary information for boilerplate 15 are listed in table 7-1.

Table 7-1. Boilerplate 15 Supplementary Documents

Document No.	Title	Contents
SM1A-1	Apollo Support Manual Index	This manual contains a complete listing of Apollo support manuals.
SM2A-02	Apollo Spacecraft Familiarization Handbook	Description of spacecraft with all systems in overall terms.
SM2A-05-BP15	Apollo Spacecraft Transportation and Handling Procedures	Instructions for handling, packaging, packing, shipping, transporting, and storing the Apollo spacecraft for boilerplate 15 and its associated ground support equipment.
SM3A-201	Apollo Transportation and Handling Equipment Data Sheets	Maintenance procedures for transportation and handling equipment.
SM3A-202	Apollo Auxiliary Checkout and Servicing Equipment Maintenance Data Sheets	Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment.
SM3A-204	Apollo Support Equipment, Maintenance Signal Conditioner Console, Model C14-135, Part No. G16-852500-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-205	Apollo Support Equipment, Maintenance Radar Transponder and Recovery Beacon Checkout Unit, Model C14-112, Part No. G16-852900	Physical and functional description and maintenance procedures consisting of functional tests and repair.

Table 7-1. Boilerplate 15 Supplementary Documents (Cont)

Document No.	Title	Contents
SM3A-208	Apollo Support Equipment, Maintenance Data Distribution and Recording Console, Model C14-420, Part No. G16-850500-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-213	Apollo Support Equipment, Maintenance Antenna Checkout Group, Model C14-032, Part No. G16-850400-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-221	Apollo Support Equipment, Maintenance Ground Cooling Cart, Model A14-011	Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment.
SM3A-222	Apollo Support Equipment, Maintenance Launch Escape Tower Substitute Unit, Model A14-001, Part No. G16-820301-201	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-226	Apollo Support Equipment, Maintenance Pyrotechnics Bench Maintenance Equipment, Model C14-051, Part No. G16-852700-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-227	Apollo Support Equipment, Maintenance Launch Escape Sequencer Bench Maintenance Equipment, Model C14-029, Part No. G16-853400-201	Physical and functional description of test, trouble analysis, repair, servicing, packaging, and diagrams as related to boilerplate 15 configuration.
SM3A-228	Apollo Support Equipment, Maintenance Launch Vehicle Substitute Unit, Model A14-021, Part No. G16-821300	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-229	Apollo Support Equipment, Maintenance Optical Alignment Set, Model A14-028, Part No. G17-824010	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-235	Apollo Support Equipment, Maintenance Launch Control Group, Model C14-414, Part No. G16-853950-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-263	Apollo Support Equipment, Maintenance Water-Glycol Cooling Unit, Model S14-052, Part No. G16-848020	Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment.

Table 7-1. Boilerplate 15 Supplementary Documents (Cont)

Document No.	Title	Contents
SM3A-272	Apollo Support Equipment, Maintenance MSFC Patch and Logic Distribution Sub Unit, Model A14-075, Part No. G16-853060	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-273	Apollo Support Equipment, Maintenance Umbilical Junction Box, Model C14-192, Part No. G16-852850	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM4A-200-BP15	Apollo Spacecraft Maintenance BP15	Maintenance procedures consisting of testing, trouble analysis, repair, removal and installation, and calibration and adjustment as related to boilerplate 15 configuration.

7-5. SUPPORTING EQUIPMENT.

7-6. Supporting equipment for boilerplate 15 is the ground support equipment GSE listed in table 7-2. All listed GSE has been shop-released and approved by NASA.

Table 7-2. Ground Support Equipment

Model No.	Nomenclature	Part No.	Description
A14-001	Launch escape tower substitute unit	G16-820301-201	Provides electrical interface normally presented by LES to the command module.
A14-007	LES optical alignment set	G15-824040	Consists of two pieces; a telescope adapter and a target. The set provides means of aligning thrust vector of LE motor in relation to gross CG of abort configuration.
A14-009	Spacecraft adapter cover	G18-828001	A lightweight, synthetic, impregnated, fabric raincoat to protect adapter from sand, dust, rain, and salt spray.
A14-011	Ground cooling cart	ME-362-0002-0001	The cart will filter, cool, dehumidify, or heat ambient air to suitable level for introduction into interior of command module.
A14-020	S/M cover	G17-828003	A lightweight, synthetic, impregnated fabric fitted to conform to shape of S/M and used to protect S/M from sand, rain, and salt spray during handling, transportation and storage.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
A14-021	Launch vehicle substitute unit C1	G16-821300	Provides interface for power to Q-ball heater and Q-ball electronics. It also provides access to monitor signals that may be returned from Q-ball electronics package.
A14-024	Fluid and electrical umbilical disconnect set	G16-828010-101	Interconnects spacecraft automatic and manually activated fluid servicing connections with appropriate fluid distribution systems.
A14-026	Cap and plug set	G14-828012-301	Consists of covers, caps, and plugs for all electrical, hydraulic, and mechanical disconnects; duct, pipe, and interface openings; and areas to be protected from shipping and handling damage.
A14-027	Adapter cap and plug set	G18-828002	Consists of covers, caps, and plugs for all electrical, hydraulic, and mechanical disconnects; duct, pipe, and interface openings; and areas to be protected from shipping and handling damage.
A14-076	Spacecraft GSE crossover distributor	G16-853056	Junction box for electrical cables.
C14-112	Radar transponder and recovery beacon checkout unit	G16-852900	Rack-mounted drawers. Rack is mounted on wheels and is approximately five feet in height. Drawers contain the following equipment: electronic counter, frequency meter, coax panel, signal generator, power control panel, blower, power meter drawer, oscilloscope, pulse generator, and cable drawer.
C14-135	Signal conditioner console	G16-852500-101	Consists of a signal conditioner drawer, relay drawer, and panel terminal board. The signal conditioner will amplify very small signals from pressure and temperature transducers.
C14-186	Electrical cable set	G16-850065	Consists of 50 cables, the lengths varying from 6 to 70 feet. The cables are used to transfer electrical power, monitor and control signals to and from spacecraft and ground support equipment.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
C14-191	Terminal distributor	G16-851300	Cabinet, mounted to floor in test area and providing connection points between the spacecraft and various GSE units. Cabinet contains fuses, terminal blocks, and a power distribution panel with circuit breakers.
C14-414	Launch control group	G16-853950	Group consists of five system panels on drawer assemblies mounted in a five-bay equipment rack. The panels are: test conductor panel, electrical power system panel, instrumentation and communication systems panel, environmental control system panel, and launch escape system panel.
C14-420	Data distribution and recording console	G16-850500	Provides means of integrating data signals from spacecraft, Marshall Space Flight Control Panel (MSFC), and NAA ground support equipment panels. The system also provides monitoring and/or recording capability for all signals routed through console.
H14-016	LES weight and balance fixture	G15-810029	Fixture consists of two welded square tubing structures bolted together and supported by short jacks. The upper surface of frame has six level mounting pads for mounting load cells and a laterally and vertically adjustable cradle to support and position LES components.
H14-018	Escape tower support	G15-810026	Welded tubular structure equipped with four clamps to secure tower and four roller assemblies to rails of the H14-011 alignment stand and H14-052 positioning trailer.
H14-021	GSE handling cart	G14-810050	Can be used to transport lighweight miscellaneous components such as load cell kits and removable pieces from equipment, tools, etc.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-074	Spacecraft sling (with LES)	G15-818001-101	Consists of lifting eye, galvanized cables, spreader bar, rocket motor clamp assembly, and tie rods running from this clamp to attach points on skirt of LES. The sling is used to assemble launch escape system on command module, and for lifting both to a position on top of service module.
H14-109	S/M external access stand	G17-810070	Square platform having a circular cutout to clear the S/M, mounted on a scaffolding erected to reach the topmost area of the S/M. The platform is constructed of reinforced wood and the scaffolding of tubular steel. The platform is ringed with a protective rail of tubular steel.
H14-111	Access ladder, command module hatch	G16-810162	A stepladder that may be positioned on H14-109 workstand platform and allowed to rest against command module for entrance to hatch.
H14-127	Cable and fitting set, weight and balance, service module adapter	G17-810220	Consists of conical-shaped buttons with shank for installation into aft interface of spacecraft adapter and/or extension. The set is used during weight and balance operations.
H14-139	Forward compartment heat shield retention bolt guide	G16-810245	The bolt guide is tapered, and screws over retention bolts for thread protection and acts as a guide during heat shield installation.
H14-9076	General-purpose dolly	G16-810033-101	Consists of a welded rectangular steel frame, four lateral support brackets, and necessary tie-down brackets. Unit has lockable casters bolted to each corner of frame and removable tow bar assembly with swivel-type brackets in front and back of frame.
S14-052	Water-glycol cooling unit	G16-848020	A steel enclosure mounted on skids and containing all necessary controls and instrumentation for local operation.

SECTION VIII

ELECTRICAL SCHEMATICS

8-1. PURPOSE.

8-2. This section consists of the electrical wiring schematic for boilerplate 15.

8-3. SCHEMATIC DIAGRAMS.

8-4. The combined systems schematic diagram for boilerplate 15 and GSE hanger checkout equipment is shown in figure 8-1.

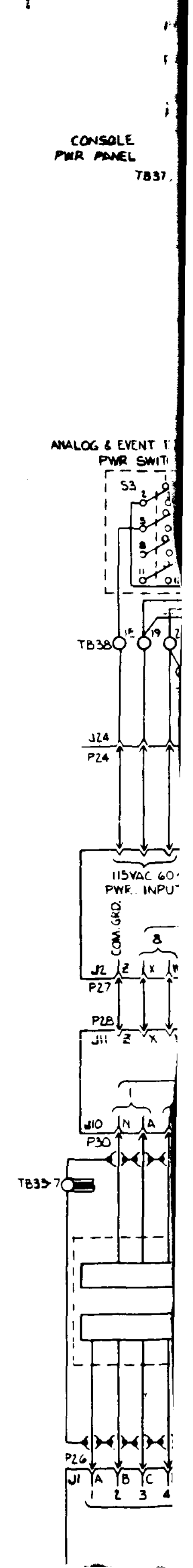
RANGE TABLE

RANGE	-50° TO +200°C	-20° TO +100°C	0° TO +150°C	0° TO +204°C	0° TO +380°C
R6	842	763	778	806	806
R8	12500	2500	3300	5600	8000
R9	11200	13335	1390	14000	14000
R12	30000	40000	40000	40000	40000
R13	3000	4000	4000	4000	4000
R14	279.5	111.6	300	427	558.5
R15	2000	1000	1000	2000	2000

Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 1 of 5)

RECORDER PATCH PANEL
TABULATION CHART

SIGNAL	PATCH PANEL	
	INPUT	TO REC



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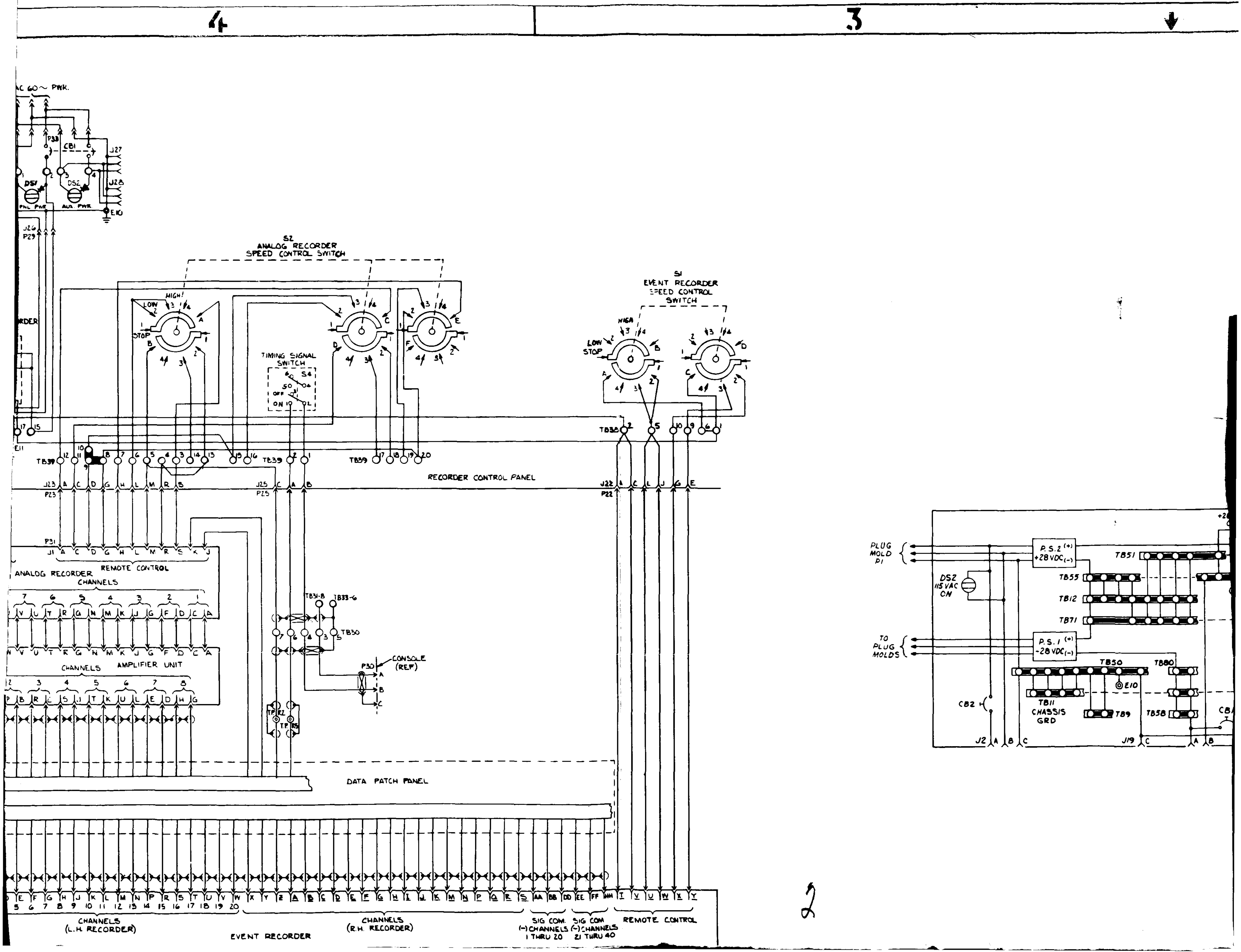
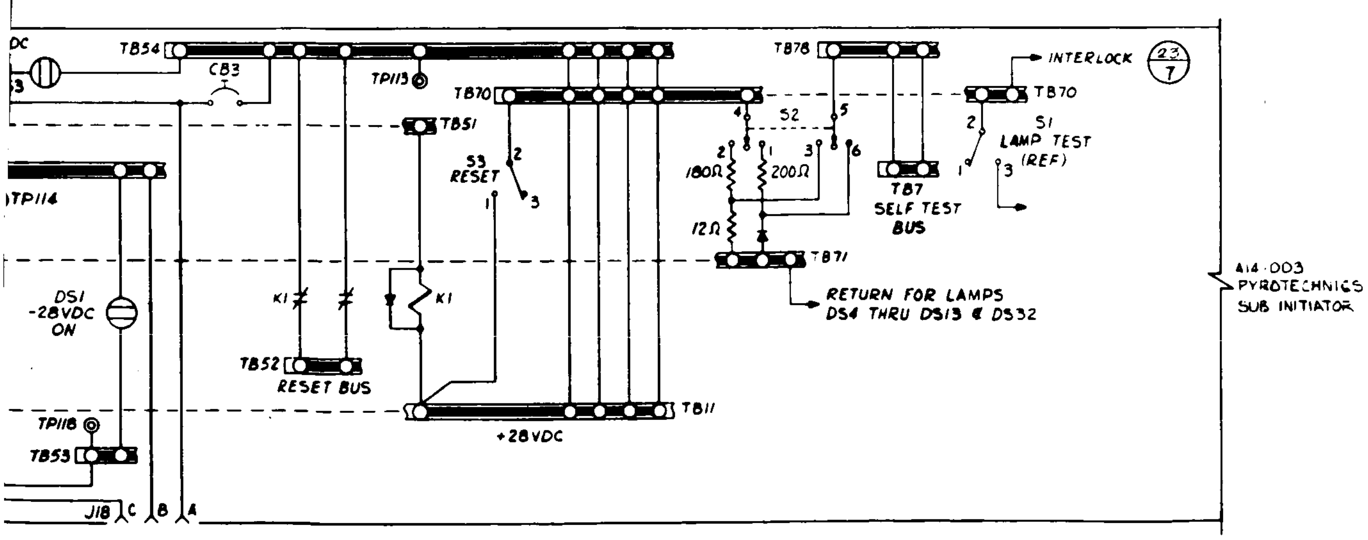


4
3
S2
ANALOG RECORDER
SPEED CONTROL SWITCH
S1
EVENT RECORDER
SPEED CONTROL
SWITCH
TIMING SIGNAL
SWITCH
S4
RECORDER CONTROL PANEL
REMOTE CONTROL
ANALOG RECORDER
CHANNELS
AMPLIFIER UNIT
CONSOLE
(REF)
DATA PATCH PANEL
CHANNELS
(L.H. RECORDER)
EVENT RECORDER
CHANNELS
(R.H. RECORDER)
SIG COM.
(-) CHANNELS
1 THRU 20
SIG COM
(-) CHANNELS
21 THRU 40
REMOTE CONTROL
PLUG
MOLD
P1
TO
PLUG
MOLDS
DS2
115 VAC
ON
P.S. 2
+28 VDC
P.S. 1
-28 VDC
TB11
CHASSIS
GRD
2

2



RELATED DRAWINGS

UNIT	SCHEMATIC GSE	WIRING DIAGRAM
A14-003 (PYRO)	G16-982108B	G16-820589A G16-820550 G16-820551 G16-820555

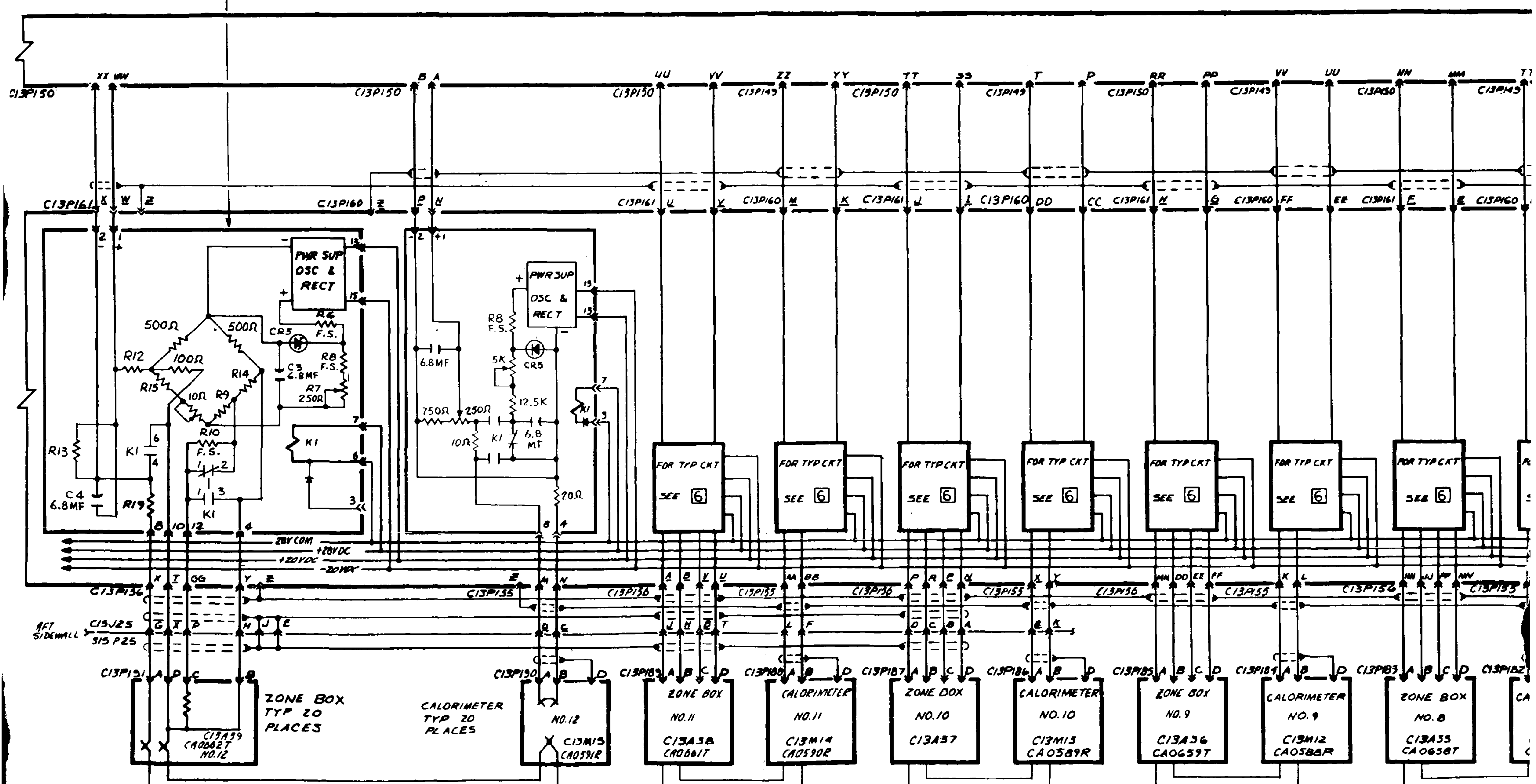
BOILERPLATE

SIGNAL COND. BOX	______	SX 540,007 (NASA)

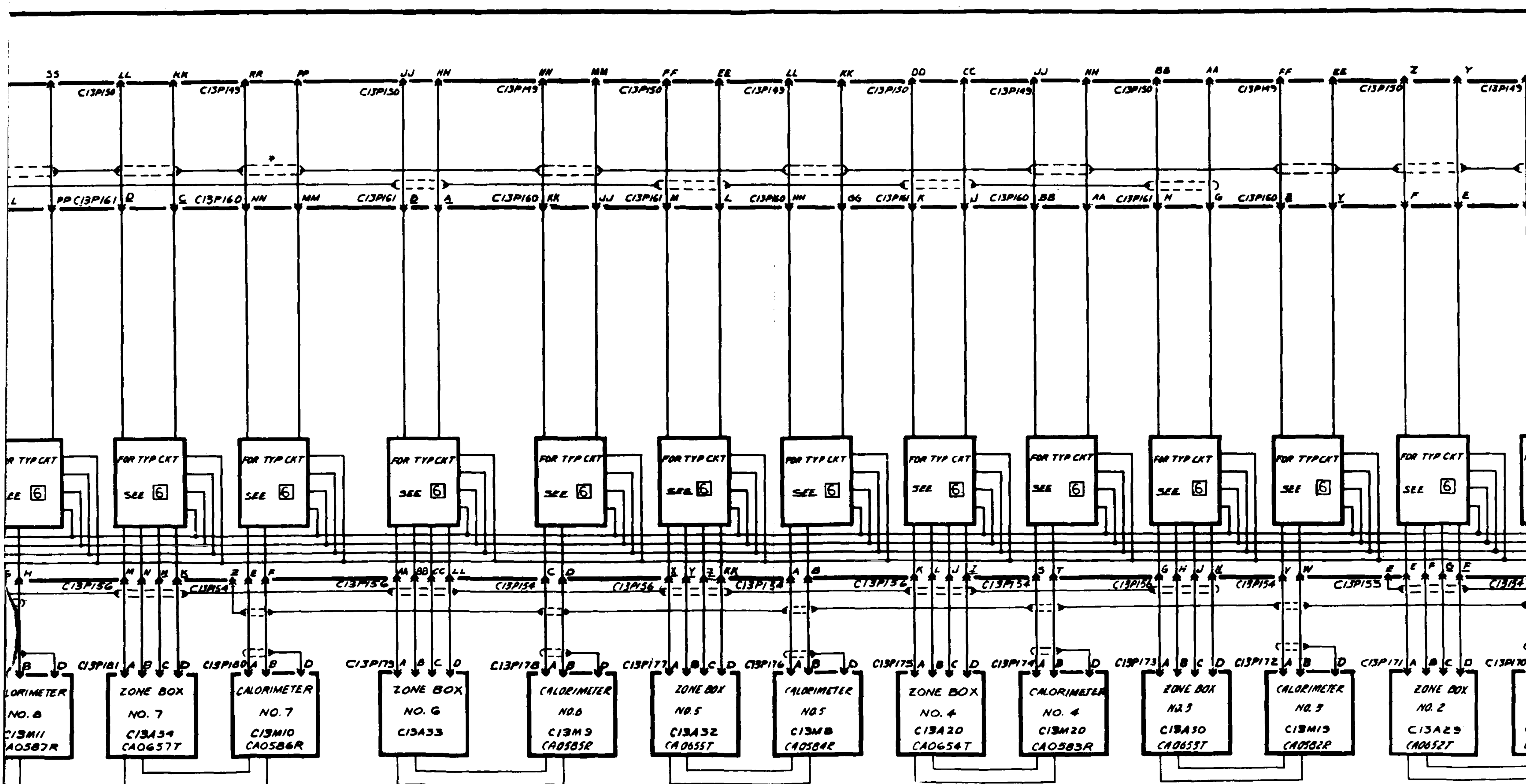
3

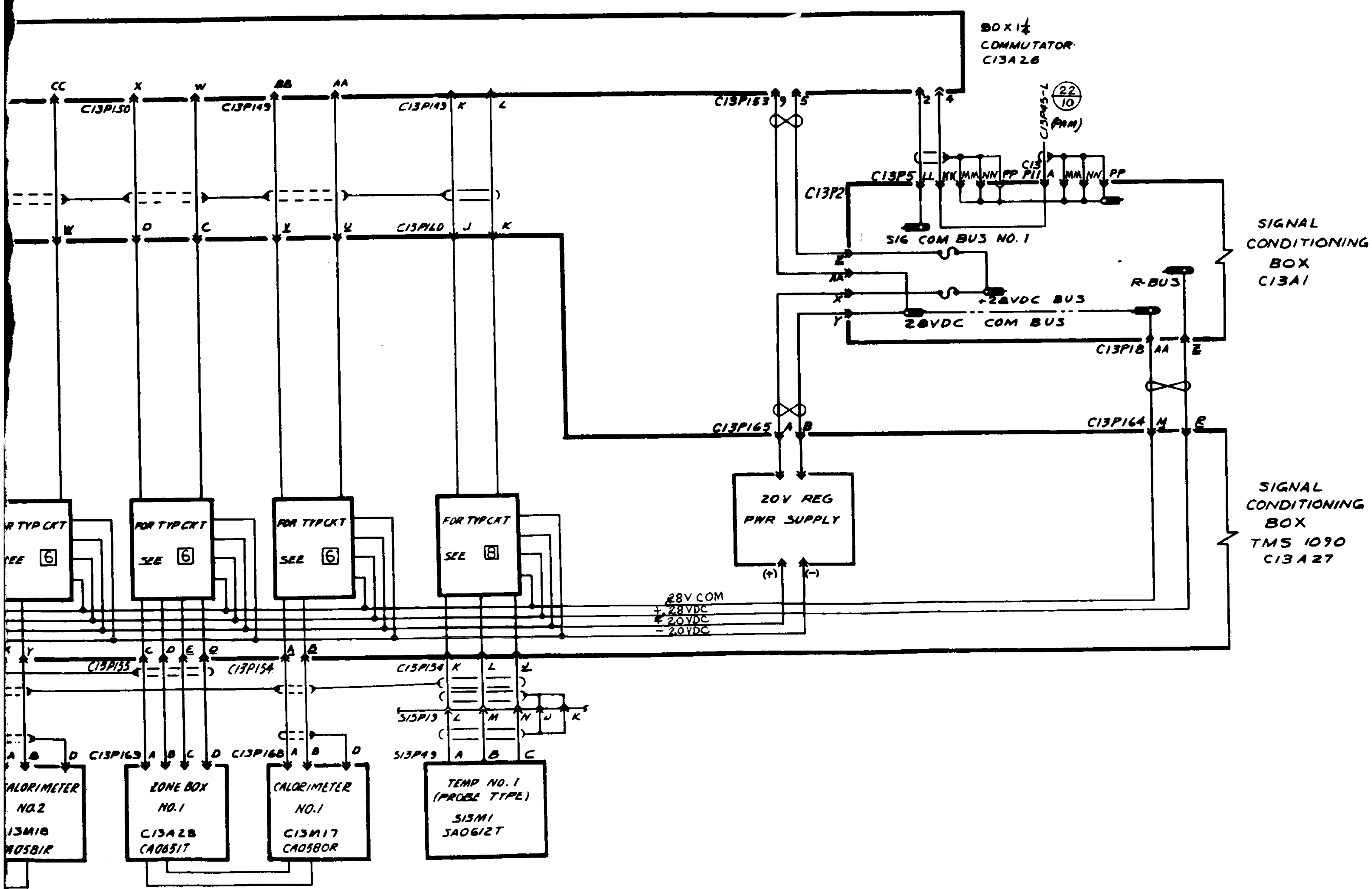
RANGE TABLE

RANGE	C-A 0-300°	C-A 0-375°	C-A 0-550°	C-A 0-800°	C-A 0-1100°	C-A 0-1200°	C-C 0-250°
R6	555	540	555	545	555	655	668
R8	2150	2120	2120	2120	2090	2150	2430
R9	300	300	300	300			
R10	85.5	93.8	100.9	128.8	159.4	169.3	78.7
R12	16.66	62.66	95.86	167.2	298.7	335.0	147.5
R13	1000	500	400	250	250	250	500
R14	400	400	400	400	400	400	NOT USED
R15	335	335	335	335	335	335	240
R19	124	124	335	365	500	500.5	133



4

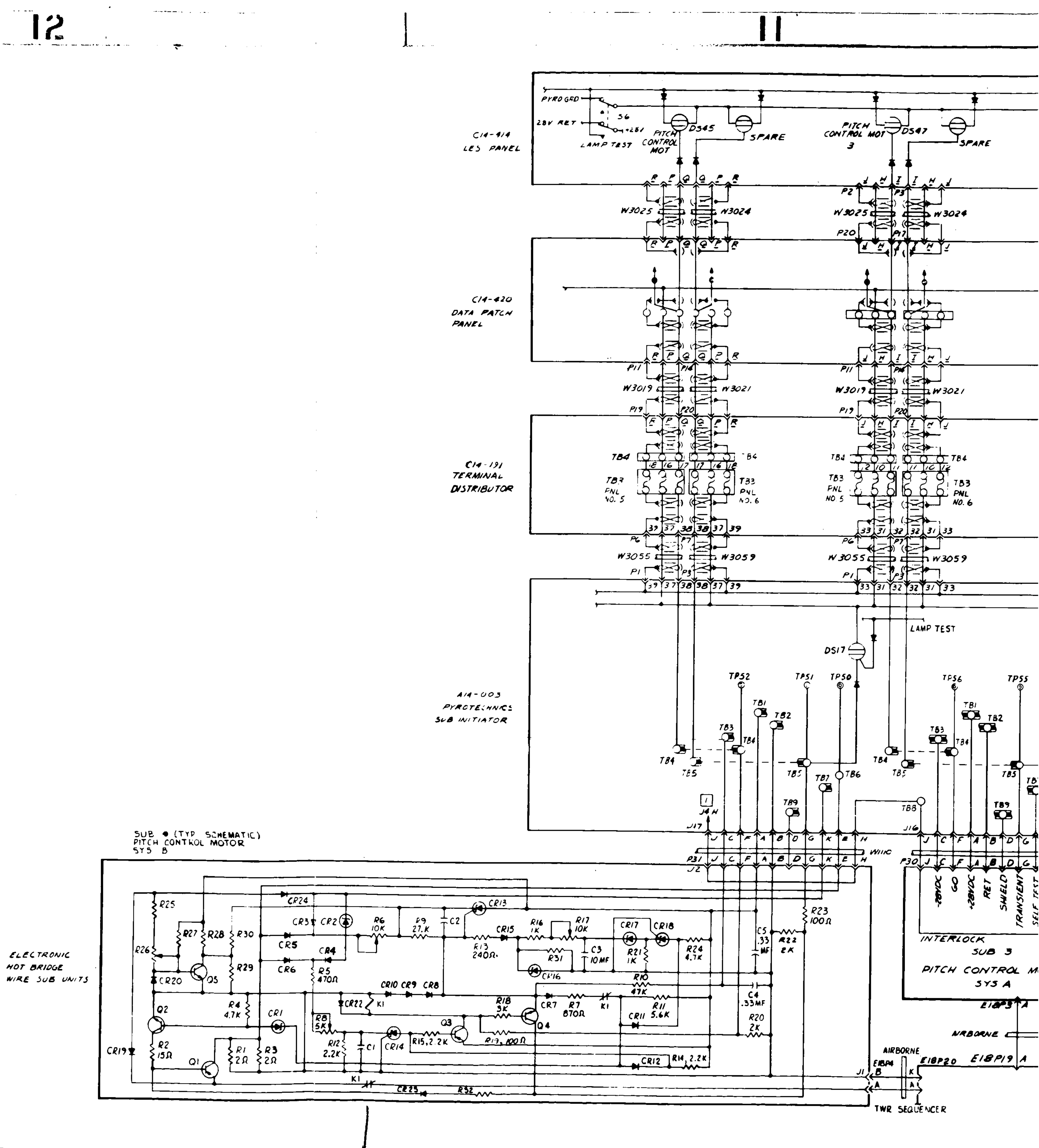

FOR TYP CKT SEE 6
ZONE BOX NO. 7 C13A34 CA0657T
CALORIMETER NO. 7 C13M10 CA0586R
ZONE BOX NO. 6 C13A33
CALORIMETER NO. 6 C13M9 CA0585R
ZONE BOX NO. 5 C13A32 CA0655T
CALORIMETER NO. 5 C13M8 CA0584R
ZONE BOX NO. 4 C13A20 CA0654T
CALORIMETER NO. 4 C13M20 CA0583R
ZONE BOX NO. 3 C13A30 CA0653T
CALORIMETER NO. 3 C13M19 CA0582R
ZONE BOX NO. 2 C13A29 CA0652T

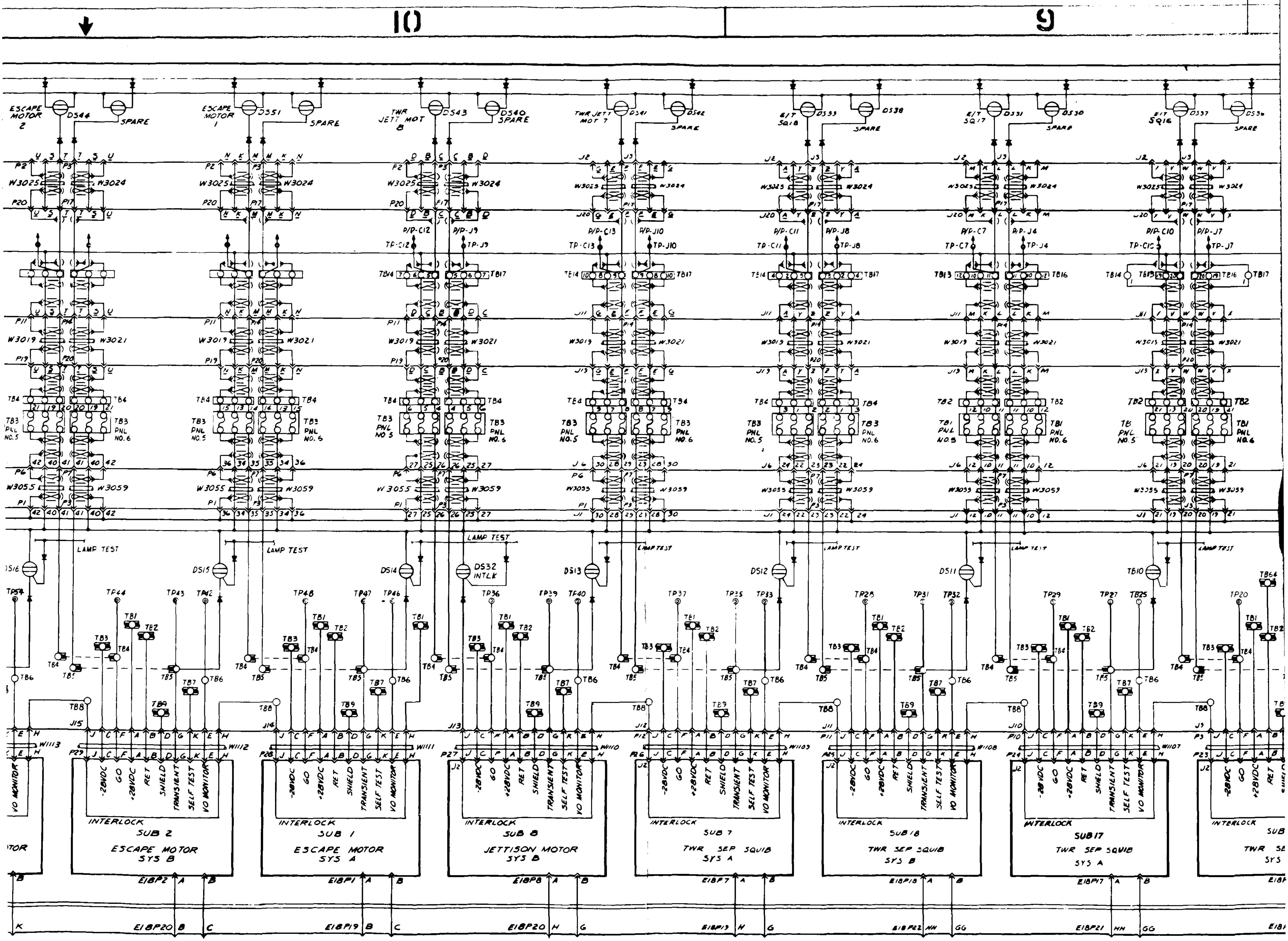


SM-2A-559

Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 2 of 5)

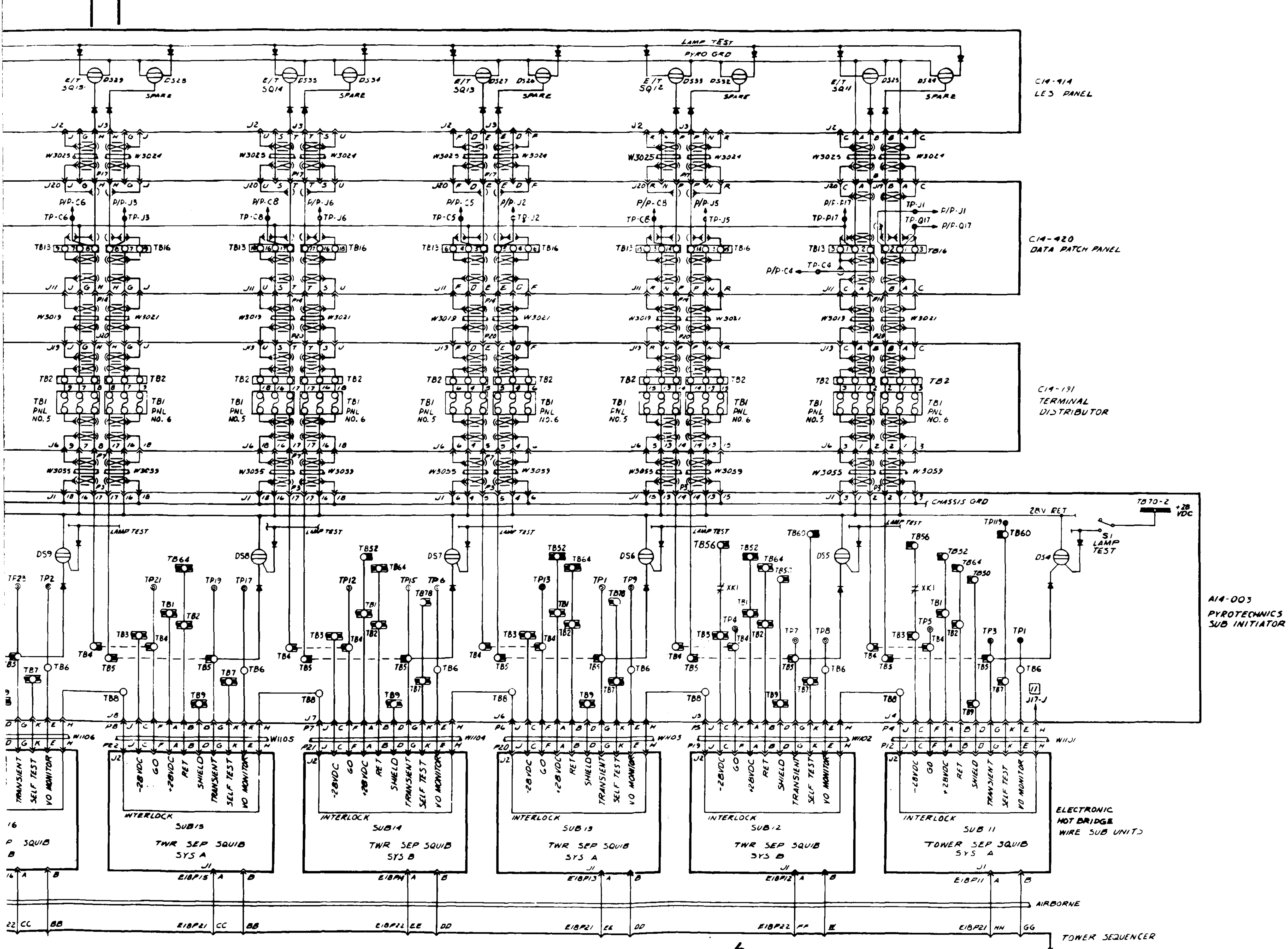
6

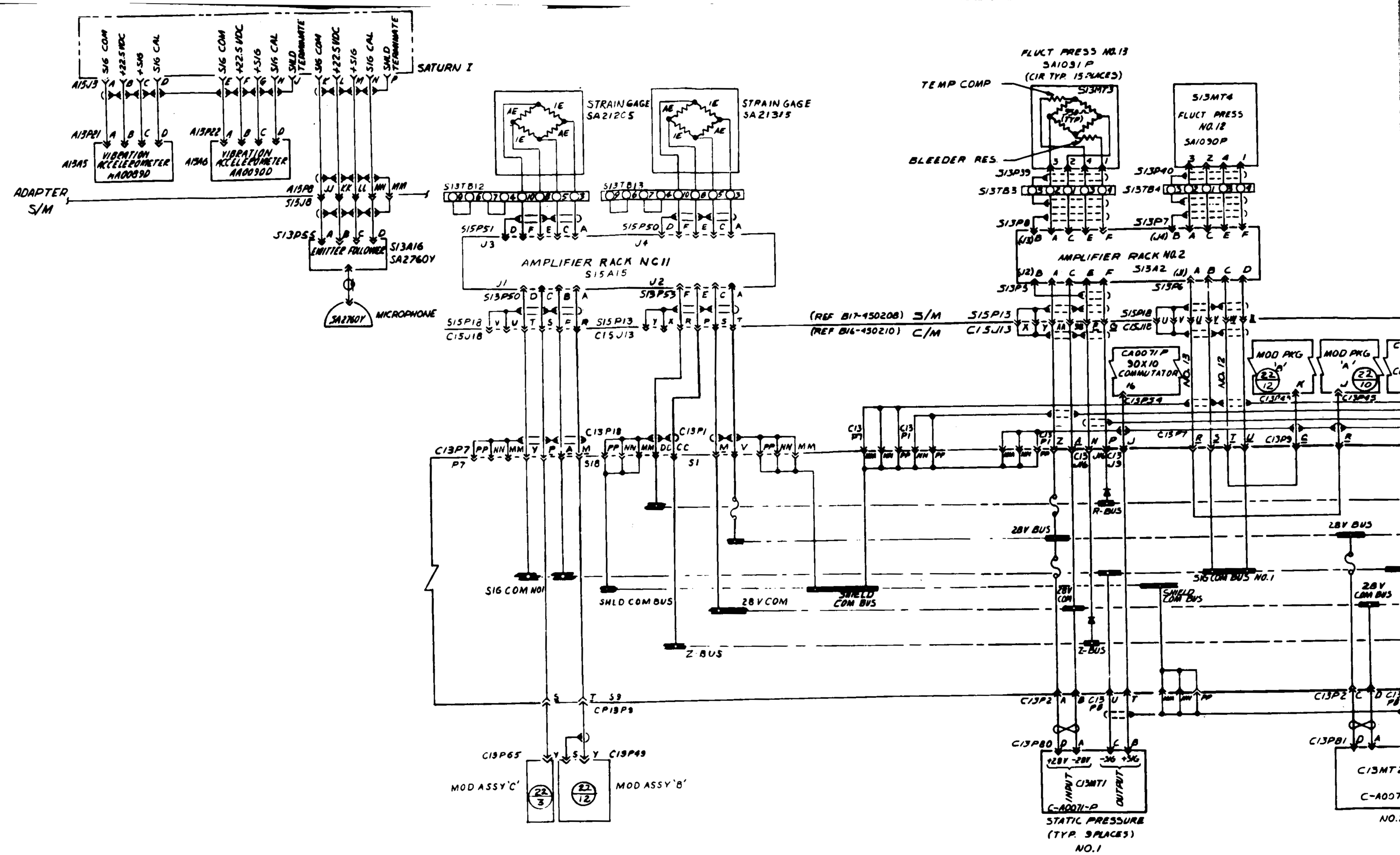

12
11
C14-414
LES PANEL
PYRO GRD
28V RET
S6
LAMP TEST
PITCH CONTROL MOT
DS45
SPARE
PITCH CONTROL MOT 3
DS47
W3025
W3024
P2
P3
P20
P17
C14-420
DATA PATCH PANEL
P11
P14
W3019
W3021
P19
P20
C14-191
TERMINAL DISTRIBUTOR
TB4
TB3
PNL NO. 5
PNL NO. 6
P6
P7
W3055
W3059
P1
P3
LAMP TEST
DS17
A14-003
PYROTECHNICS SUB INITIATOR
TP52
TP51
TP50
TP56
TP55
TB1
TB2
TB3
TB4
TB5
TB6
TB7
TB8
TB9
J17
J16
J4
P31
P30
J2
SUB ● (TYP SCHEMATIC)
PITCH CONTROL MOTOR
SYS B
ELECTRONIC HOT BRIDGE WIRE SUB UNITS
INTERLOCK
SUB 3
PITCH CONTROL
SYS A
AIRBORNE
E18P4
E18P20
E18P19
J1
TWR SEQUENCER
R23 100Ω
R22 2K
C5 .33 MF
C4 .33MF
R20 2K
R24 4.7K
R21 1K
R10 47K
R11 5.6K
R7 870Ω
R18 3K
R13 240Ω
R16 1K
R17 10K
C3 10MF
R6 10K
R9 27.K
R5 470Ω
R4 4.7K
R2 15Ω
R1 2Ω
R3 2Ω
R8 5K
R12 2.2K
R15 2.2K
R19 100Ω
R14 2.2K
R25
R26
R27
R28
R29
R30
R31
R32
Q1
Q2
Q3
Q4
Q5
K1
C1
C2
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR9
CR10
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
CR19
CR20
CR22
CR23
CR24


10
9
ESCAPE MOTOR 2
DS44
SPARE
ESCAPE MOTOR 1
DS51
TWR JETT MOT 8
DS43
DS40
TWR JETT MOT 7
DS41
DS42
E/T SQ18
DS39
DS38
E/T SQ17
DS31
DS30
E/T SQ16
DS37
W3025
W3024
W3019
W3021
W3055
W3059
P/P-C12
P/P-J9
TP-C12
TP-J9
P/P-C13
P/P-J10
TP-C13
TP-J10
P/P-C11
P/P-J8
TP-C11
TP-J8
P/P-C7
P/P-J4
TP-C7
TP-J4
P/P-C10
P/P-J7
TP-C10
TP-J7
TB14
TB17
TB13
TB16
TB4
TB3 PNL NO.5
TB3 PNL NO.6
TB2
TB1 PNL NO.5
TB1 PNL NO.6
LAMP TEST
DS16
DS15
DS14
DS32 INTLK
DS13
DS12
DS11
TB10
TP54
TP44
TP43
TP42
TP48
TP47
TP46
TP36
TP39
TP40
TP37
TP35
TP33
TP28
TP31
TP32
TP29
TP27
TB25
TP20
TB64
TB1
TB2
TB3
TB5
TB6
TB7
TB8
TB9
J15
J14
J13
J12
J11
J10
J9
W1113
W1112
W1111
W1110
W1109
W1108
W1107
P29
P28
P27
P26
P25
P24
P23
-28VDC
GO
+28VDC
RET
SHIELD
TRANSIENT
SELF TEST
VO MONITOR
INTERLOCK
SUB 2
ESCAPE MOTOR
SYS B
SUB 1
ESCAPE MOTOR
SYS A
SUB 8
JETTISON MOTOR
SYS B
SUB 7
TWR SEP SQUIB
SYS A
SUB 18
TWR SEP SQUIB
SYS B
SUB 17
TWR SEP SQUIB
SYS A
E18P2
E18P1
E18P8
E18P7
E18P18
E18P17
E18P20
E18P19
E18P22
E18P21

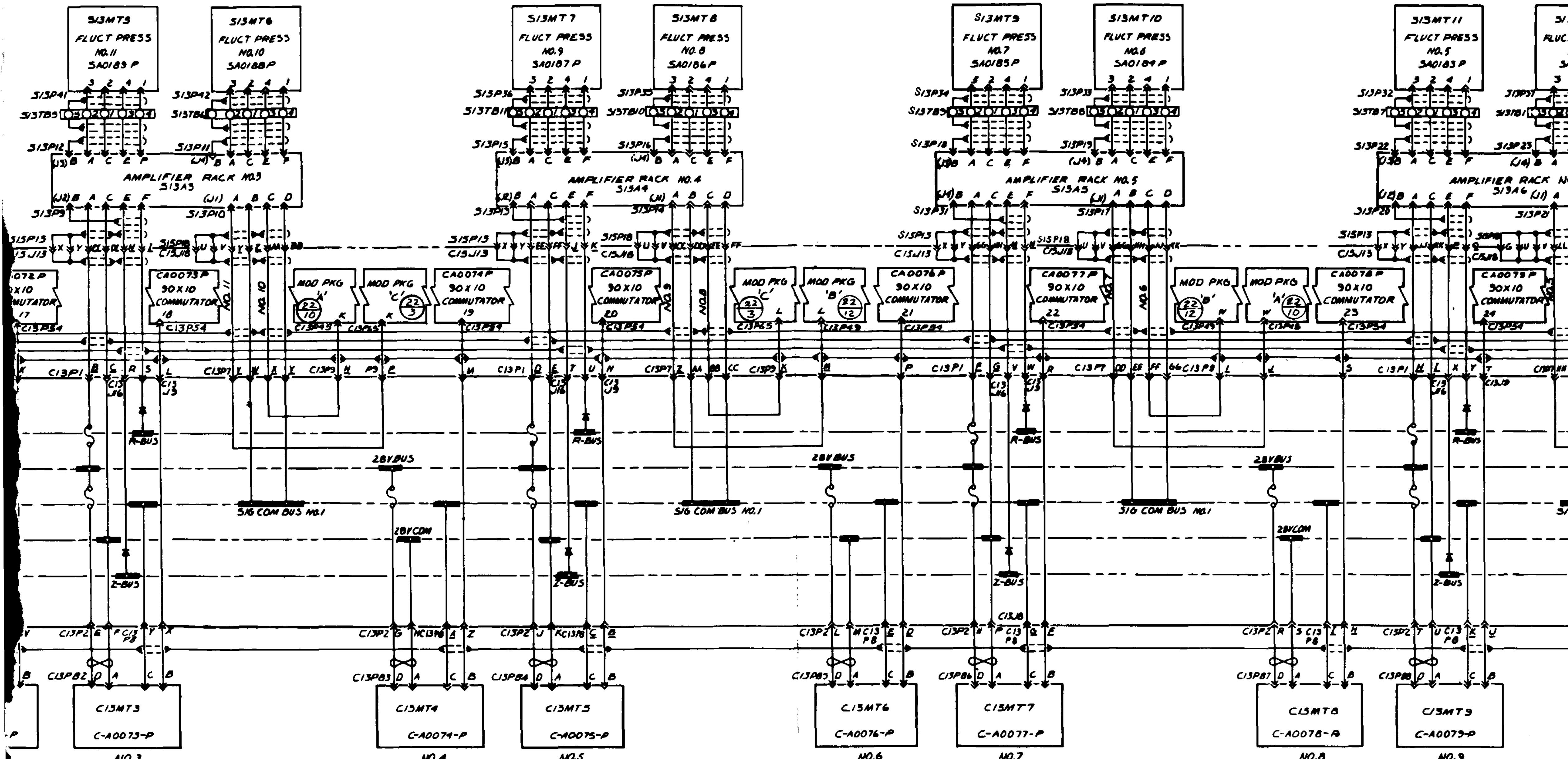
2

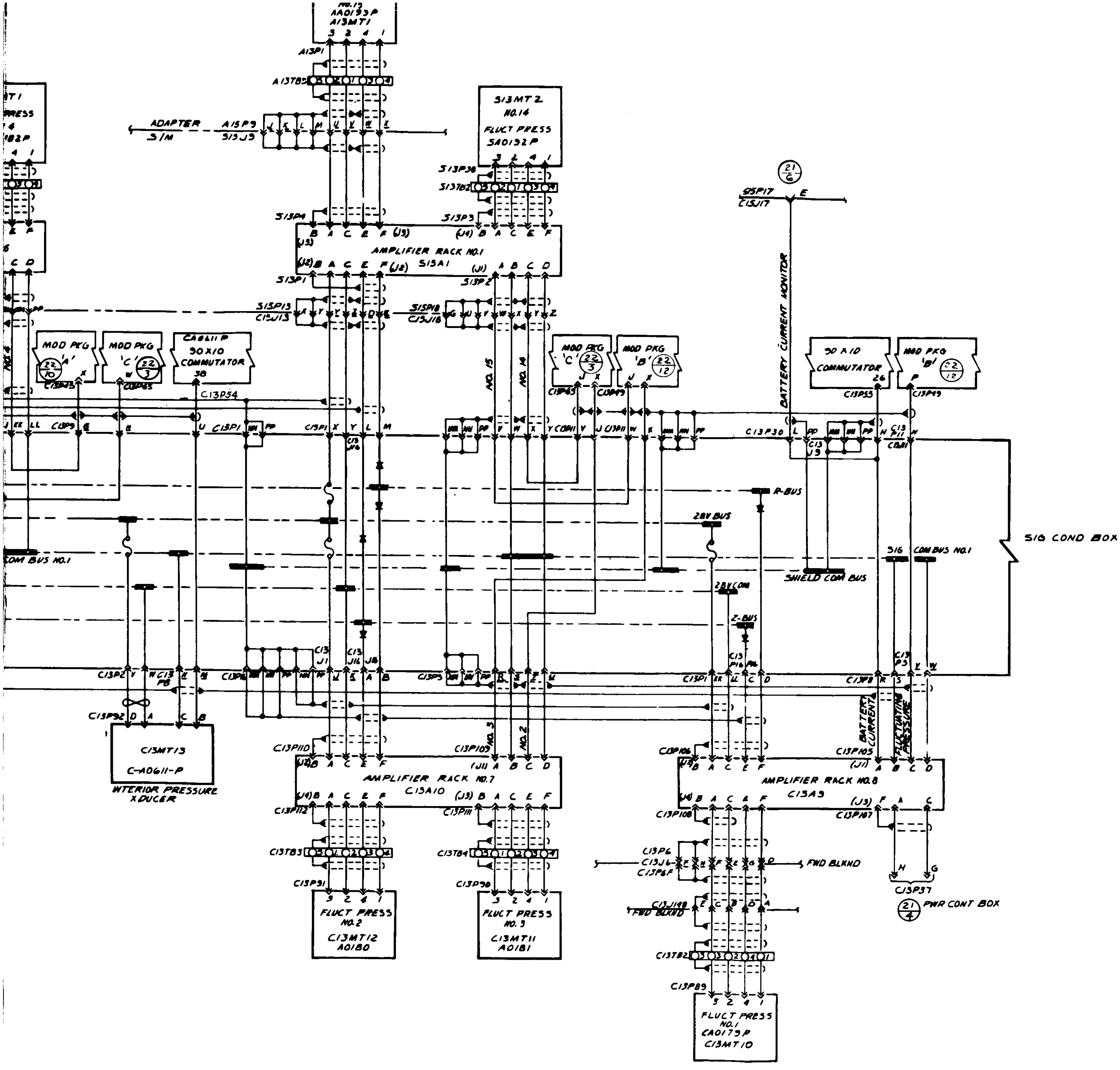
8 7


LAMP TEST
PYRO GRD
C14-414
LES PANEL
C14-420
DATA PATCH PANEL
C14-191
TERMINAL
DISTRIBUTOR
A14-003
PYROTECHNICS
SUB INITIATOR
ELECTRONIC
HOT BRIDGE
WIRE SUB UNITS
CHASSIS GRD
28V RET
S1
LAMP
TEST
TWR SEP SQUIB
SYS A
TWR SEP SQUIB
SYS B
TOWER SEP SQUIB
SYS A
AIRBORNE
TOWER SEQUENCER



SATURN I
SIG COM
+22.5 VDC
+SIG
SIG CAL
SHLD TERMINATE
A15J3
A15P21
A15P22
A15A5
A15A6
VIBRATION ACCELEROMETER AA00890
VIBRATION ACCELEROMETER AA00900
ADAPTER S/M
A15P8
S15J8
S13P55
EMITTER FOLLOWER
S13A16
SA2760Y
SA2760Y
MICROPHONE
STRAIN GAGE SA212C5
STRAIN GAGE SA21315
S13TB12
S13TB13
S15P51
S15P50
J3
J4
AMPLIFIER RACK NO 11
S15A15
J1
J2
S13P50
S13P53
S15P18
C15J18
S15P13
C15J13
(REF B17-450208) S/M
(REF B16-450210) C/M
FLUCT PRESS NO.13
SA1031P
(CIR TYP. 15 PLACES)
TEMP COMP
S13MT3
BLEEDER RES.
S13MT4
FLUCT PRESS NO.12
SA1030P
S13P39
S13P40
S13TB3
S13TB4
S13P8
S13P7
AMPLIFIER RACK NO.2
S13A2
S13P5
S13P6
S15P13
C15J13
S15P18
C15J18
CA0071P 30X10 COMMUTATOR 16
MOD PKG
C13P7
P7
C13P18
S18
C13P1
S1
C13P9
R-BUS
28V BUS
SIG COM NO1
SHLD COM BUS
28V COM
SHIELD COM BUS
Z BUS
Z-BUS
28V COM
SHIELD COM BUS
SIG COM BUS NO.1
28V COM BUS
CP13P9
S9
C13P2
C13P80
C13P81
C13P65
C13P49
MOD ASSY 'C'
MOD ASSY 'B'
C13MT1
INPUT
OUTPUT
C-A0071-P
STATIC PRESSURE
(TYP. 3 PLACES)
NO.1
C13MT2
C-A0072-
NO.2


S13MT5
FLUCT PRESS
NO.11
SA0189P
S13MT6
FLUCT PRESS
NO.10
SA0188P
S13MT7
FLUCT PRESS
NO.9
SA0187P
S13MT8
FLUCT PRESS
NO.8
SA0186P
S13MT9
FLUCT PRESS
NO.7
SA0185P
S13MT10
FLUCT PRESS
NO.6
SA0184P
S13MT11
FLUCT PRESS
NO.5
SA0183P
AMPLIFIER RACK NO.3
S13A3
AMPLIFIER RACK NO.4
S13A4
AMPLIFIER RACK NO.5
S13A5
MOD PKG
CA0073P
90X10
COMMUTATOR
18
CA0074P
90X10
COMMUTATOR
19
CA0075P
90X10
COMMUTATOR
20
CA0076P
90X10
COMMUTATOR
21
CA0077P
90X10
COMMUTATOR
22
CA0078P
90X10
COMMUTATOR
23
CA0079P
90X10
COMMUTATOR
24
R-BUS
28V BUS
28V COM
SIG COM BUS NO.1
Z-BUS
C13MT3
C-A0073-P
NO.3
C13MT4
C-A0074-P
NO.4
C13MT5
C-A0075-P
NO.5
C13MT6
C-A0076-P
NO.6
C13MT7
C-A0077-P
NO.7
C13MT8
C-A0078-P
NO.8
C13MT9
C-A0079-P
NO.9



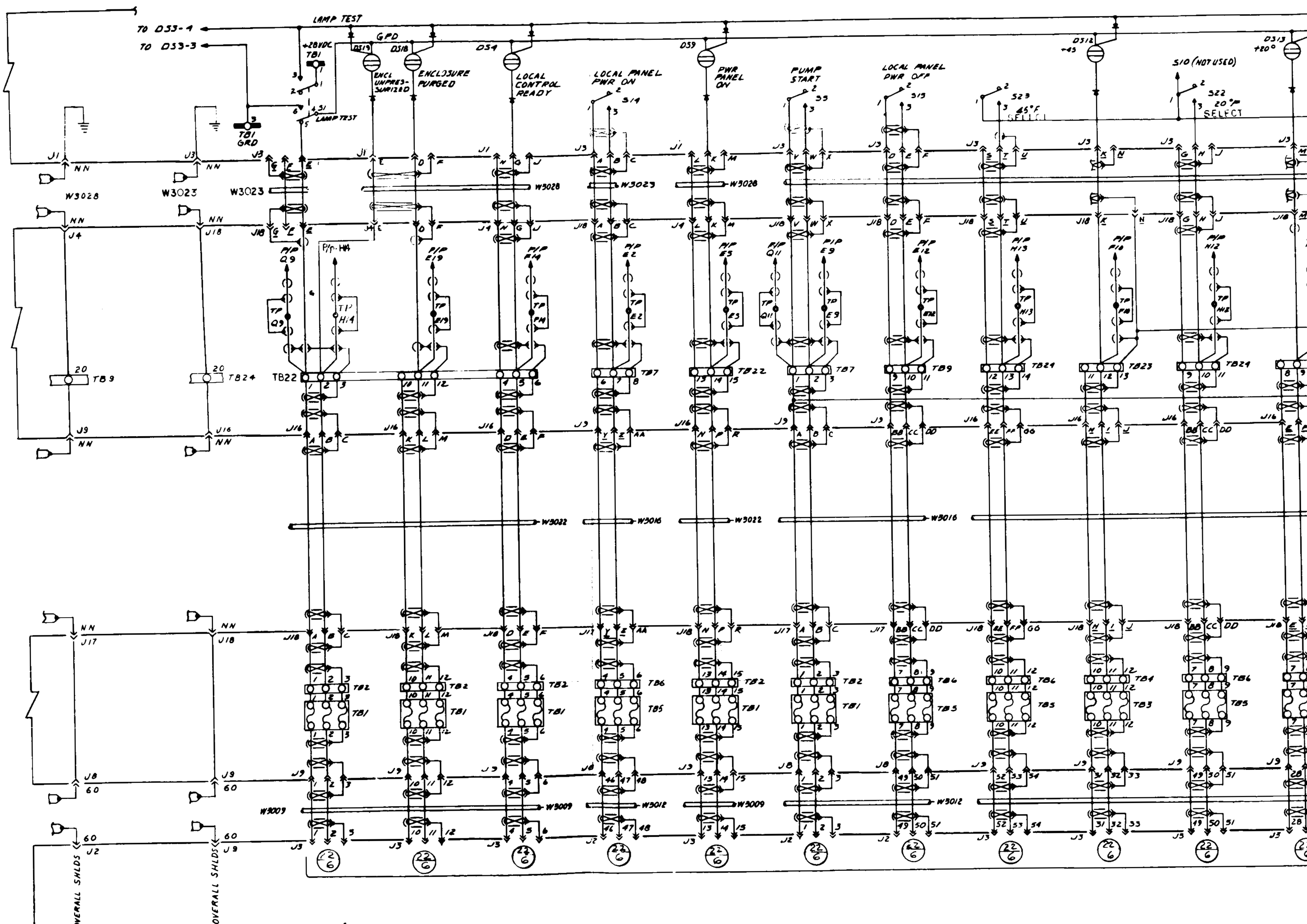
SM-2A-560

Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 3 of 5)

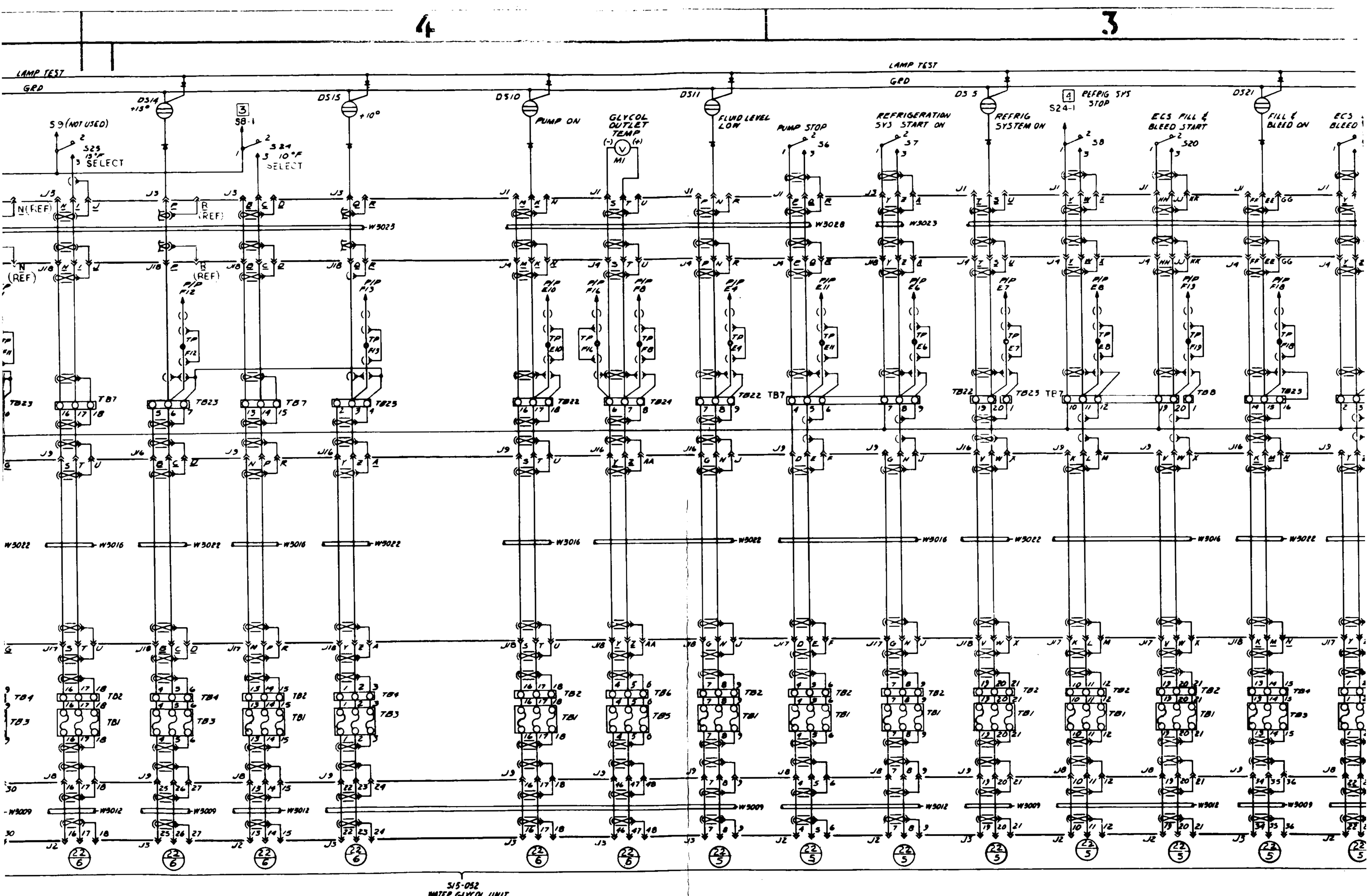
6

6

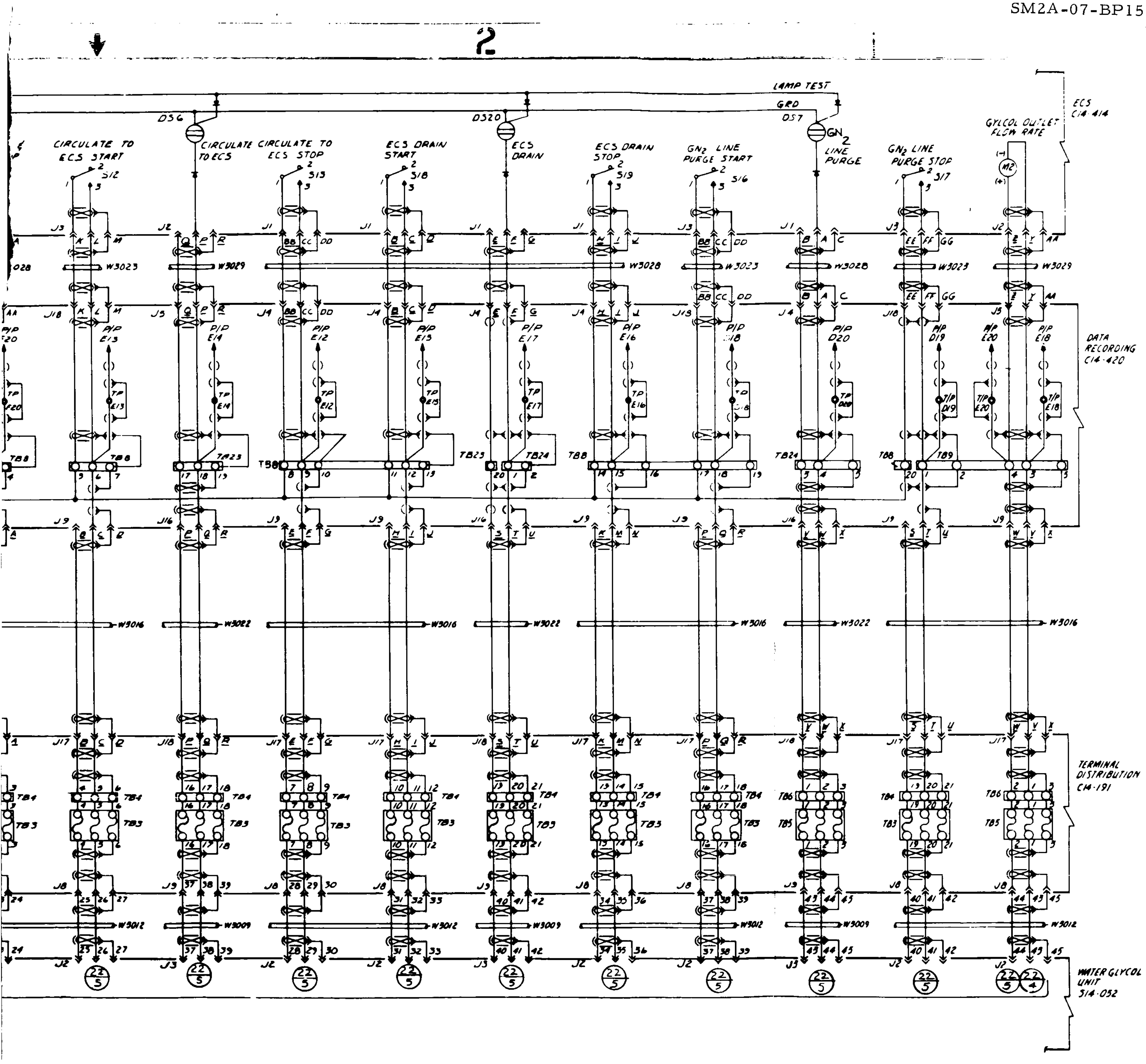
5



LAMP TEST
TO DS3-4
TO DS3-3
+28VDC
TB1
GPD
DS19
DS18
DS4
DS9
DS12
DS13
ENCL UNPRESSURIZED
ENCLOSURE PURGED
LOCAL CONTROL READY
LOCAL PANEL PWR ON
S14
PWR PANEL ON
PUMP START
S5
LOCAL PANEL PWR OFF
S15
S23
45°F SELECT
S10 (NOT USED)
S22
20°F SELECT
TB1 GRD
LAMP TEST
W3028
W3023
W3022
W3016
W3009
W3012
TB9
TB24
TB22
TB7
TB23
TB2
TB1
TB6
TB5
TB4
TB3
OVERALL SHLDS


4
3
LAMP TEST
GRD
DS14
DS15
DS10
DS11
DS5
DS21
PUMP ON
GLYCOL OUTLET TEMP
M1
FLUID LEVEL LOW
PUMP STOP
REFRIGERATION SYS START ON
REFRIG SYSTEM ON
REFRIG SYS STOP
S24-1
ECS FILL & BLEED START
FILL & BLEED ON
S9 (NOT USED)
S25 13°F SELECT
S8-1
S24 10°F SELECT
W3023
W3028
W3016
W3022
W3009
W3012
S15-052
WATER GLYCOL UNIT

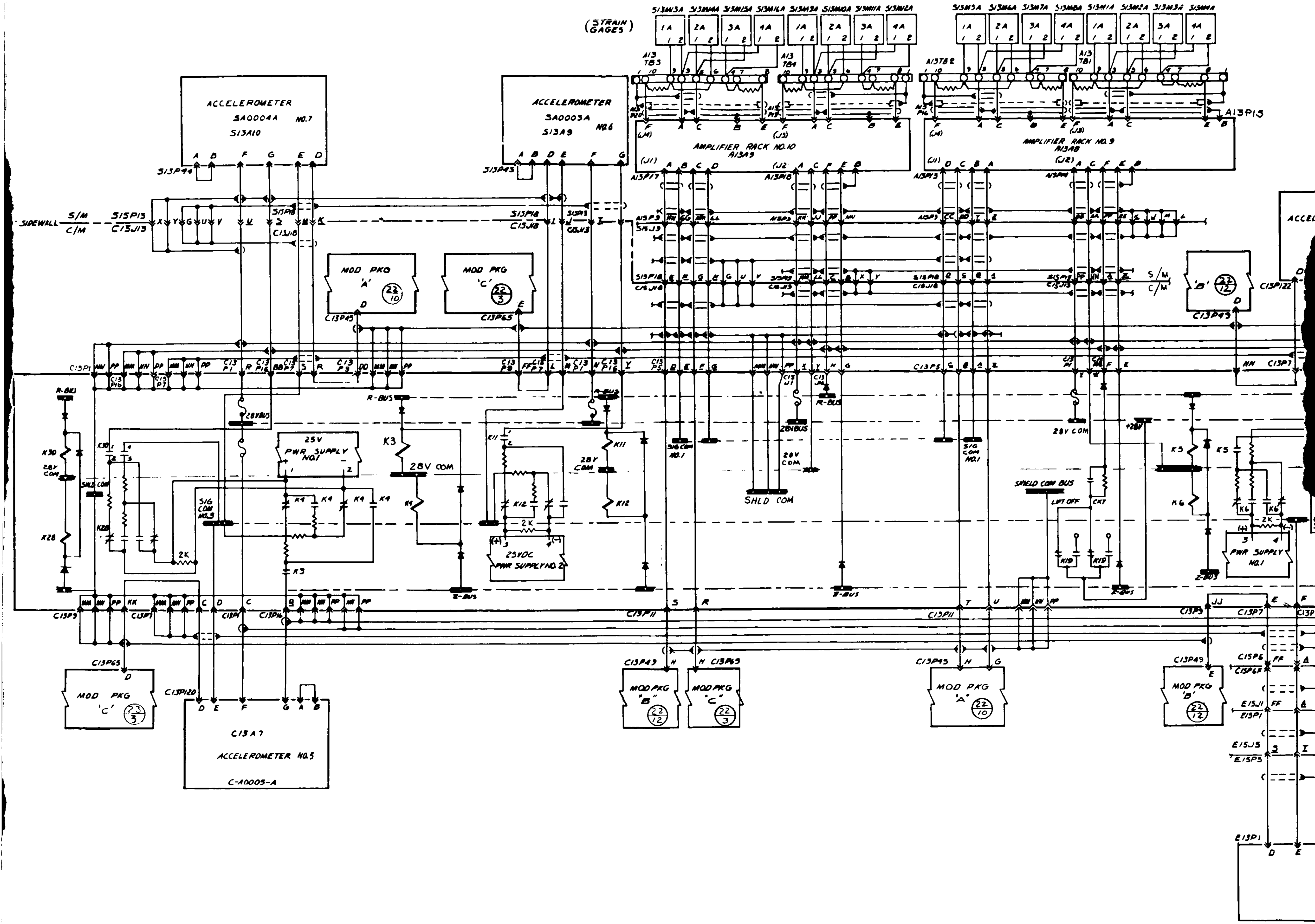
2



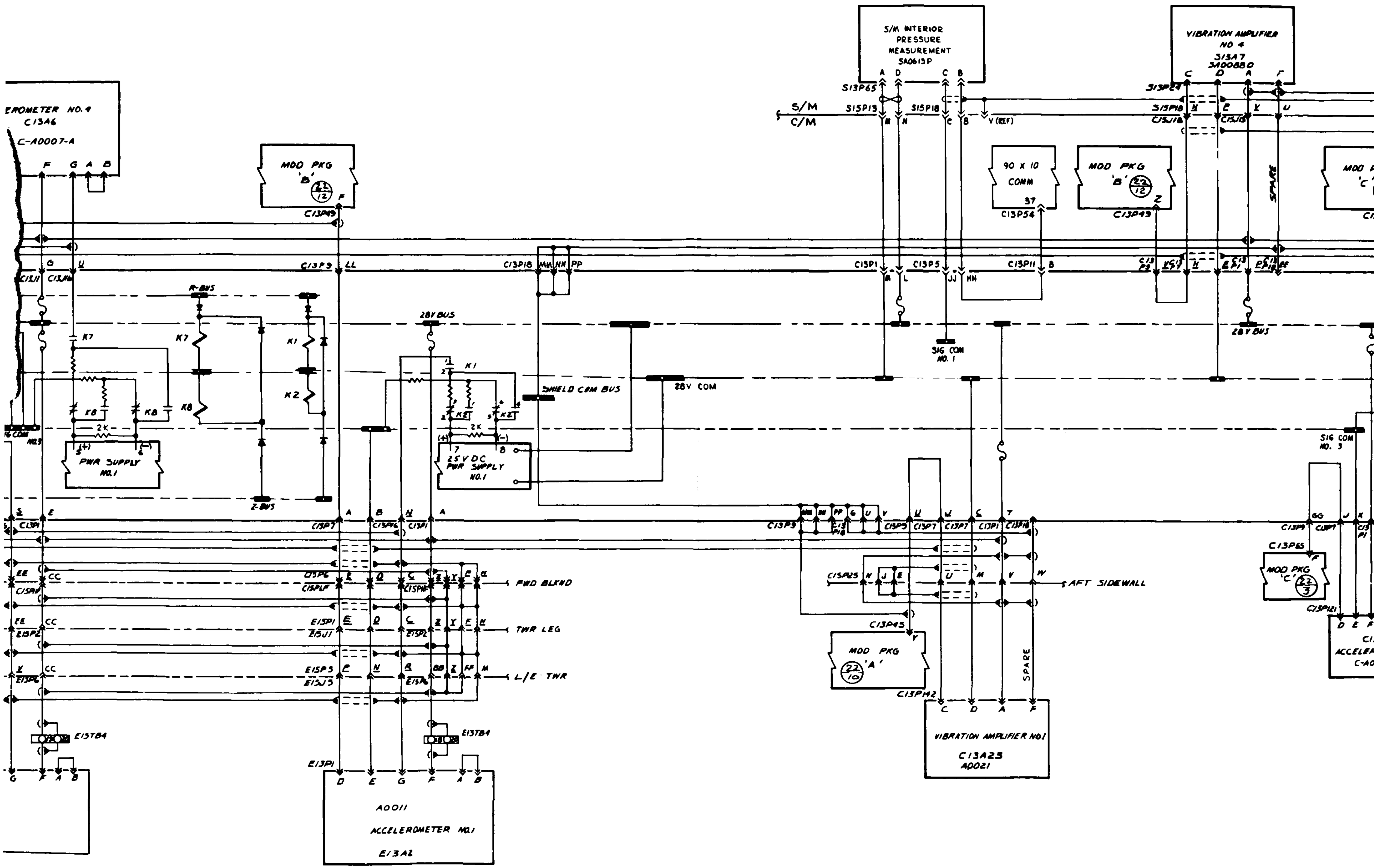
3

RELATED DRAWING

UNIT	. SCHEMATIC GSE	WIRING DIAGRAM
C14-414 (ECS)	G16-985134B	G16-853973A
(LES)	G16-985130C	G16-853983B
C14-420 (DATA DIST)	G16-985158	G16-850533


(STRAIN GAGES)
ACCELEROMETER
SA0004A NO.7
S13A10
ACCELEROMETER
SA0003A NO.6
S13A9
AMPLIFIER RACK NO.10
A13A9
AMPLIFIER RACK NO.9
A13A8
A13P15
SIDEWALL
S/M
C/M
S15P13
C13J13
MOD PKG 'A'
MOD PKG 'C'
'B'
C13P49
C13P65
R-BUS
25V PWR SUPPLY NO.1
K3
28V COM
25VDC PWR SUPPLY NO.2
SIG COM NO.3
SIG COM NO.1
SHLD COM
28VBUS
28V COM
SHIELD COM BUS
LIFT OFF
CKT
PWR SUPPLY NO.1
Z-BUS
C13P11
MOD PKG "B"
MOD PKG "C"
MOD PKG "A"
MOD PKG 'B'
MOD PKG 'C'
C13A7
ACCELEROMETER NO.5
C-A0005-A
E13P1

4


S/M INTERIOR PRESSURE MEASUREMENT
5A0613P
VIBRATION AMPLIFIER NO 4
S13A7
5A00880
EROMETER NO. 4
C13A6
C-A0007-A
MOD PKG 'B'
90 X 10 COMM
MOD PKG 'B'
MOD PK 'C'
S/M
C/M
SPARE
R-BUS
28V BUS
SHIELD COM BUS
28V COM
SIG COM NO. 1
SIG COM NO. 3
28V BUS
Z-BUS
PWR SUPPLY NO. 1
25 V DC PWR SUPPLY NO. 1
FWD BLKHD
TWR LEG
L/E TWR
AFT SIDEWALL
MOD PKG 'C'
MOD PKG 'A'
SPARE
VIBRATION AMPLIFIER NO.1
C13A23
A0021
A0011
ACCELEROMETER NO.1
E13A2
E13TB4
E13TB4

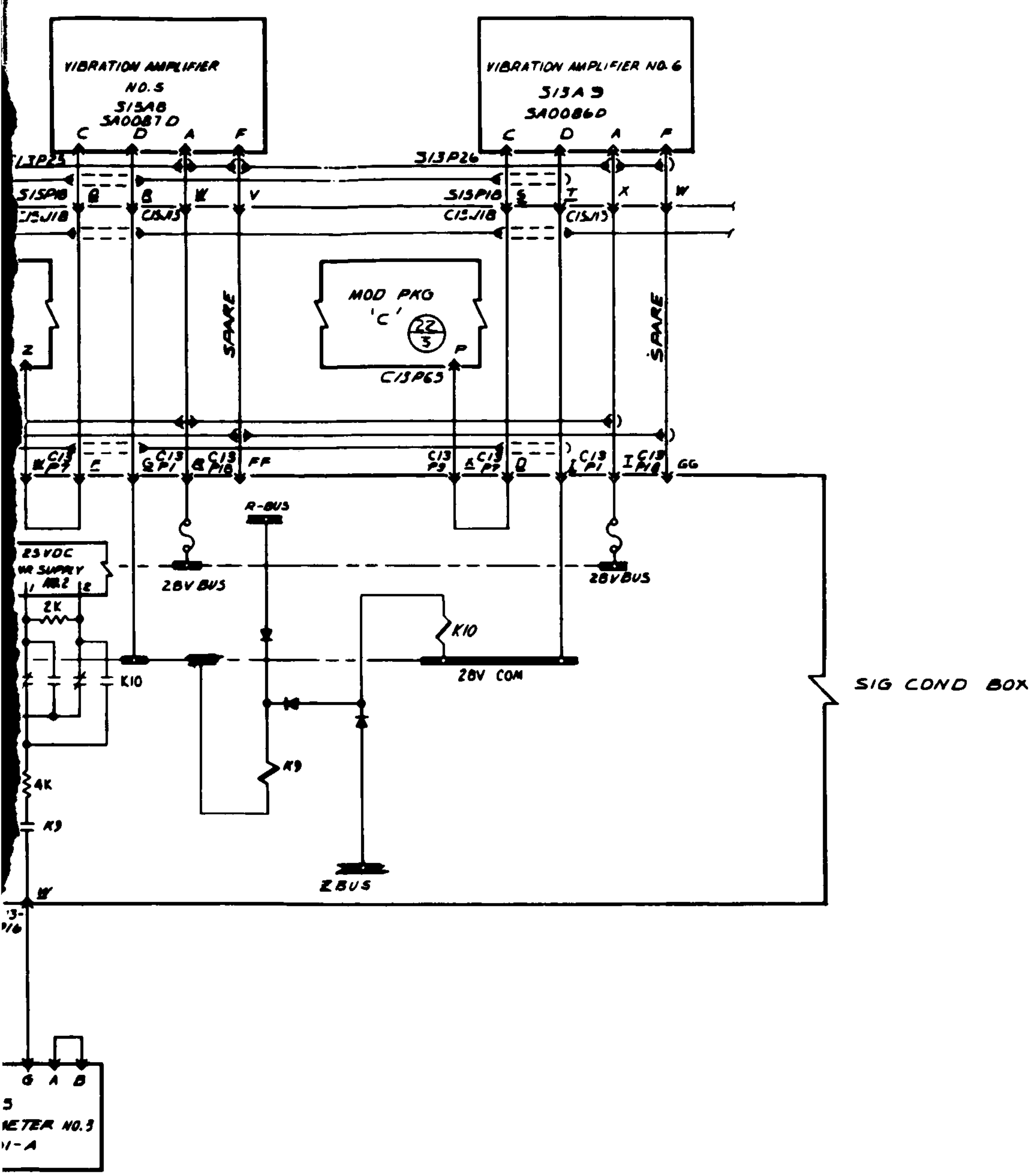
C14-191 (TERM. DIST.) ——— G16-851308 TH
G16-851315 AND
G16-851318A

A14-003 (PYRO) G16-982108B G16-820589A
G16-820550
G16-820551
G16-820555

ELECT HOT BRIDGE G16-982119A

BOILERPLATE

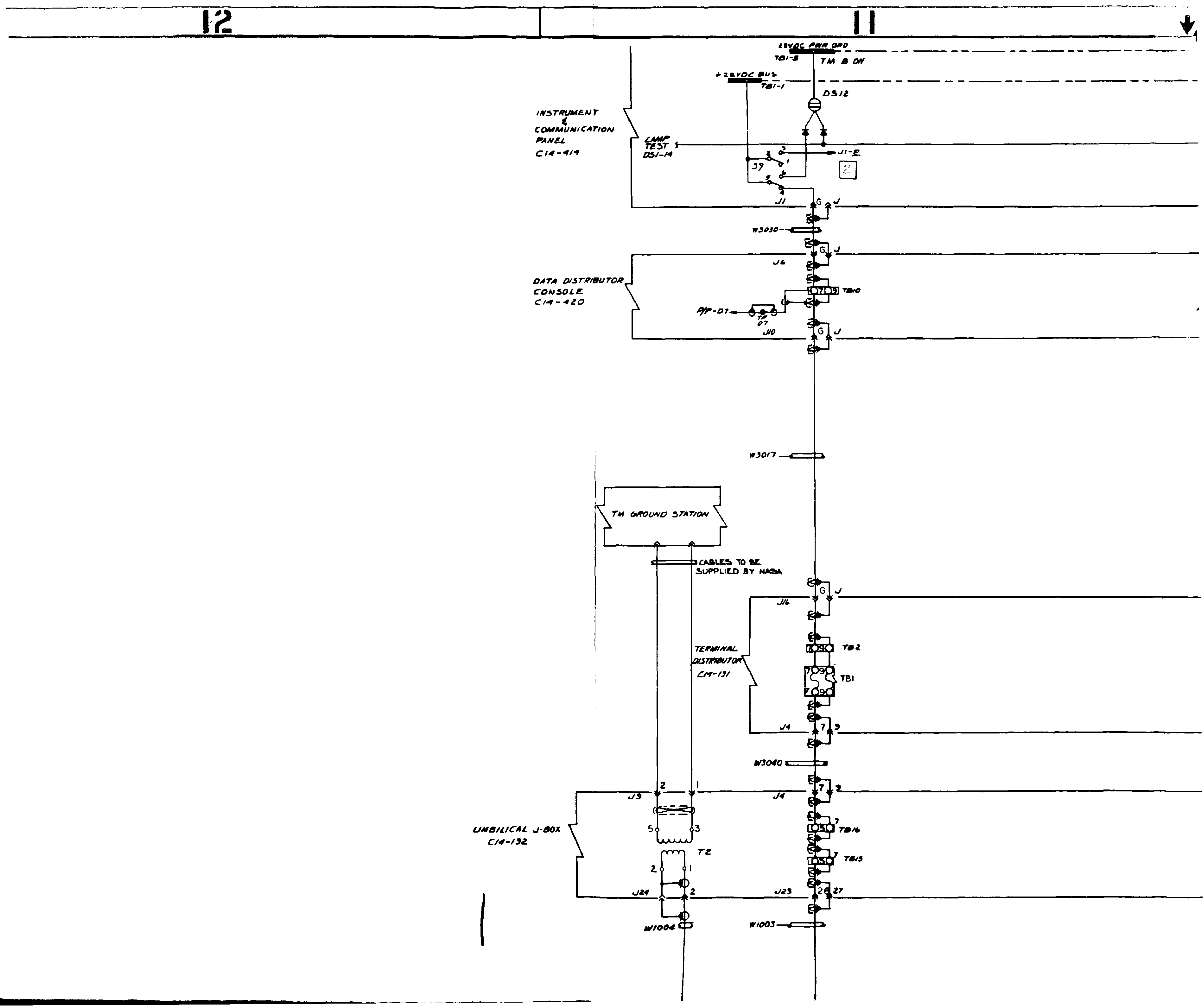
SIG COND BOX ——— SX530,106 (NASA)



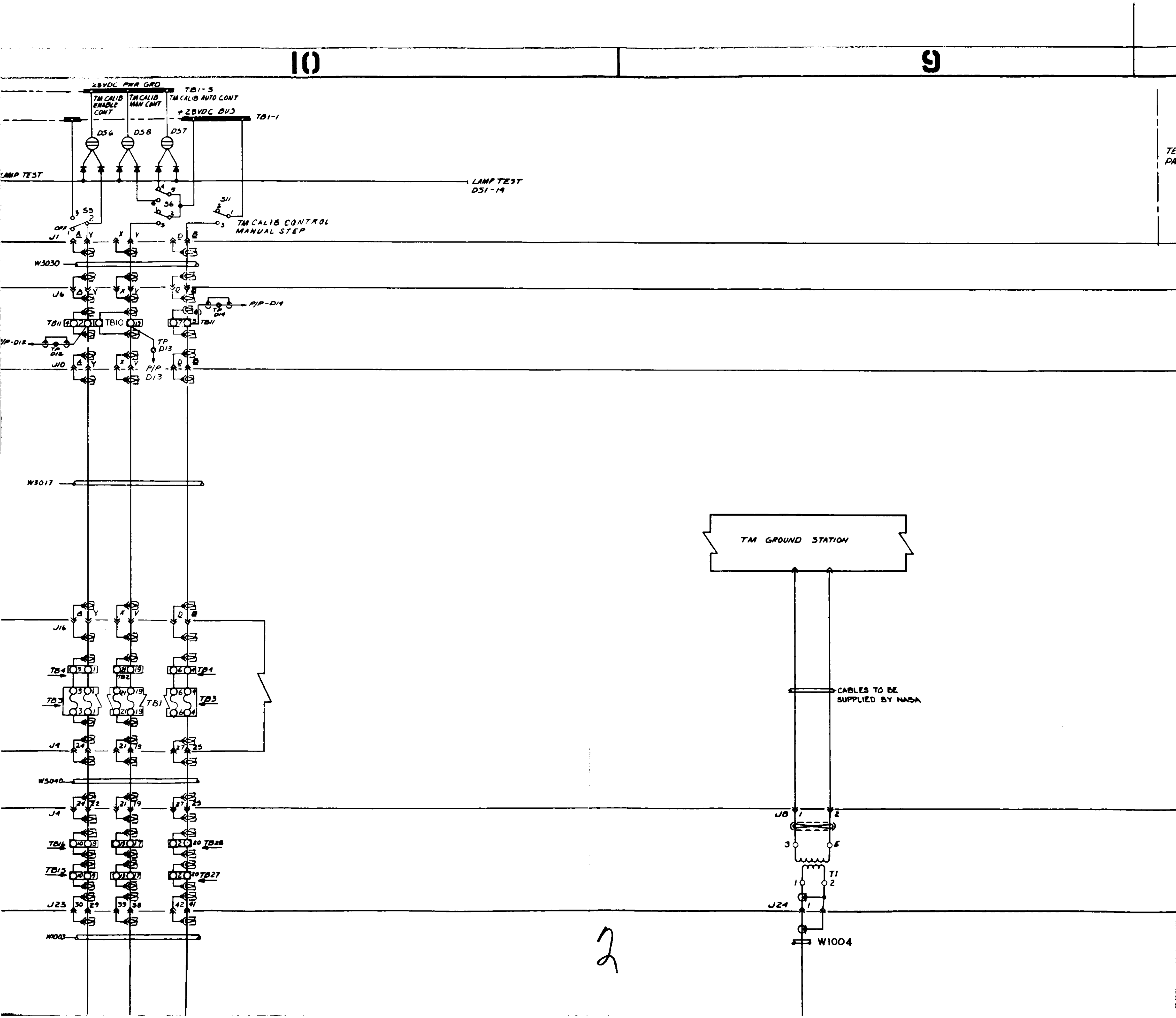
SM-2A-561

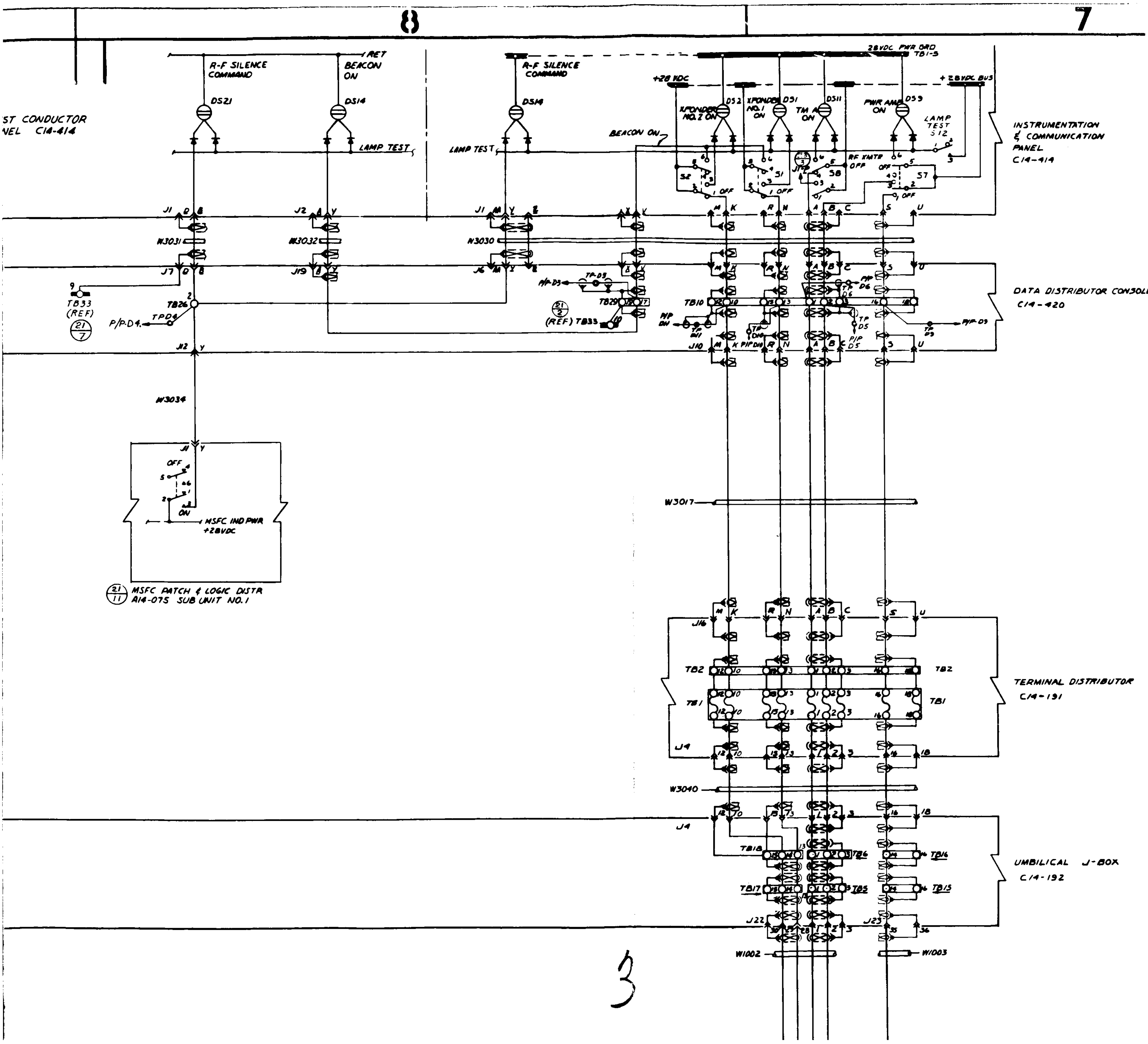
Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 4 of 5)

6

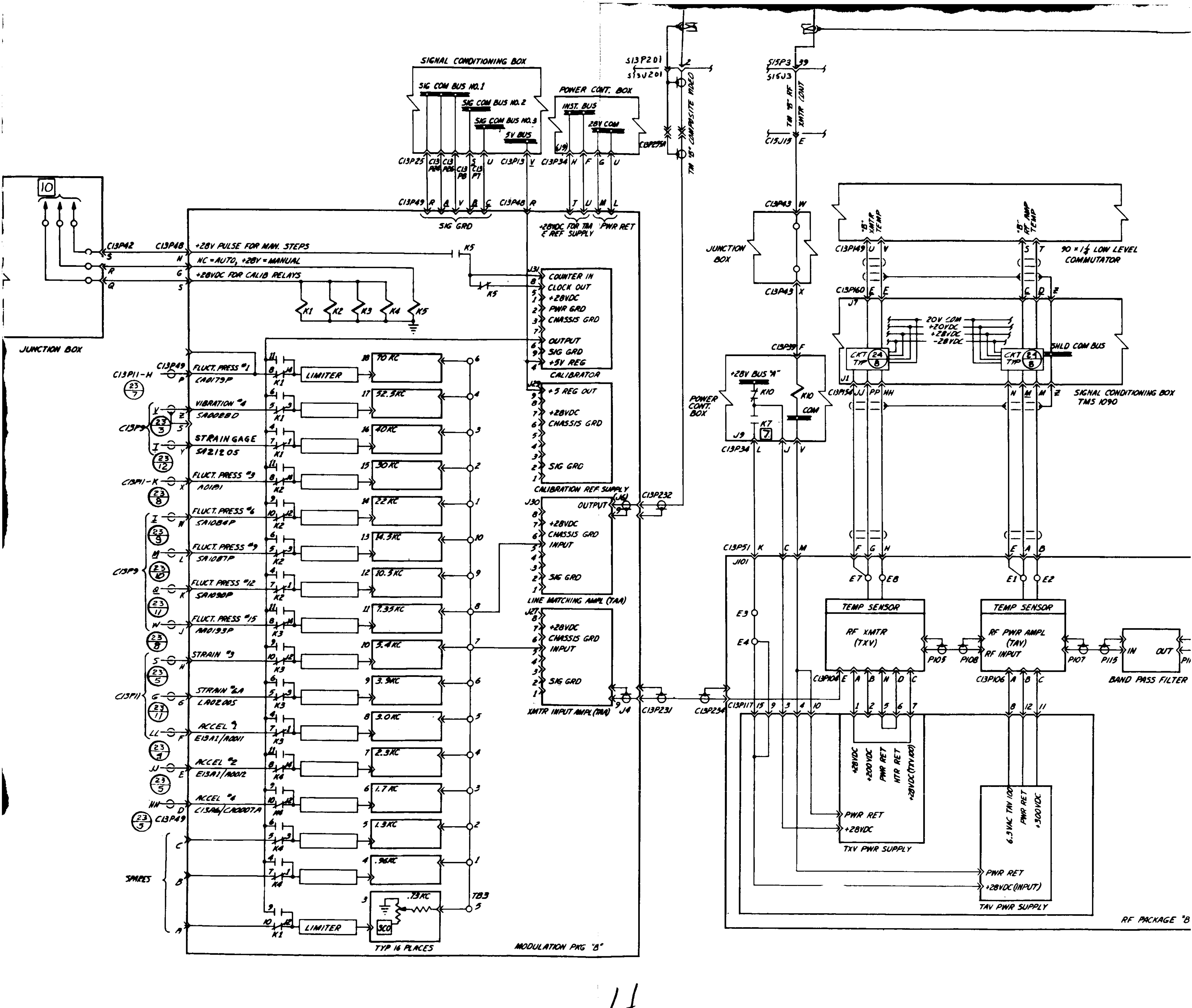


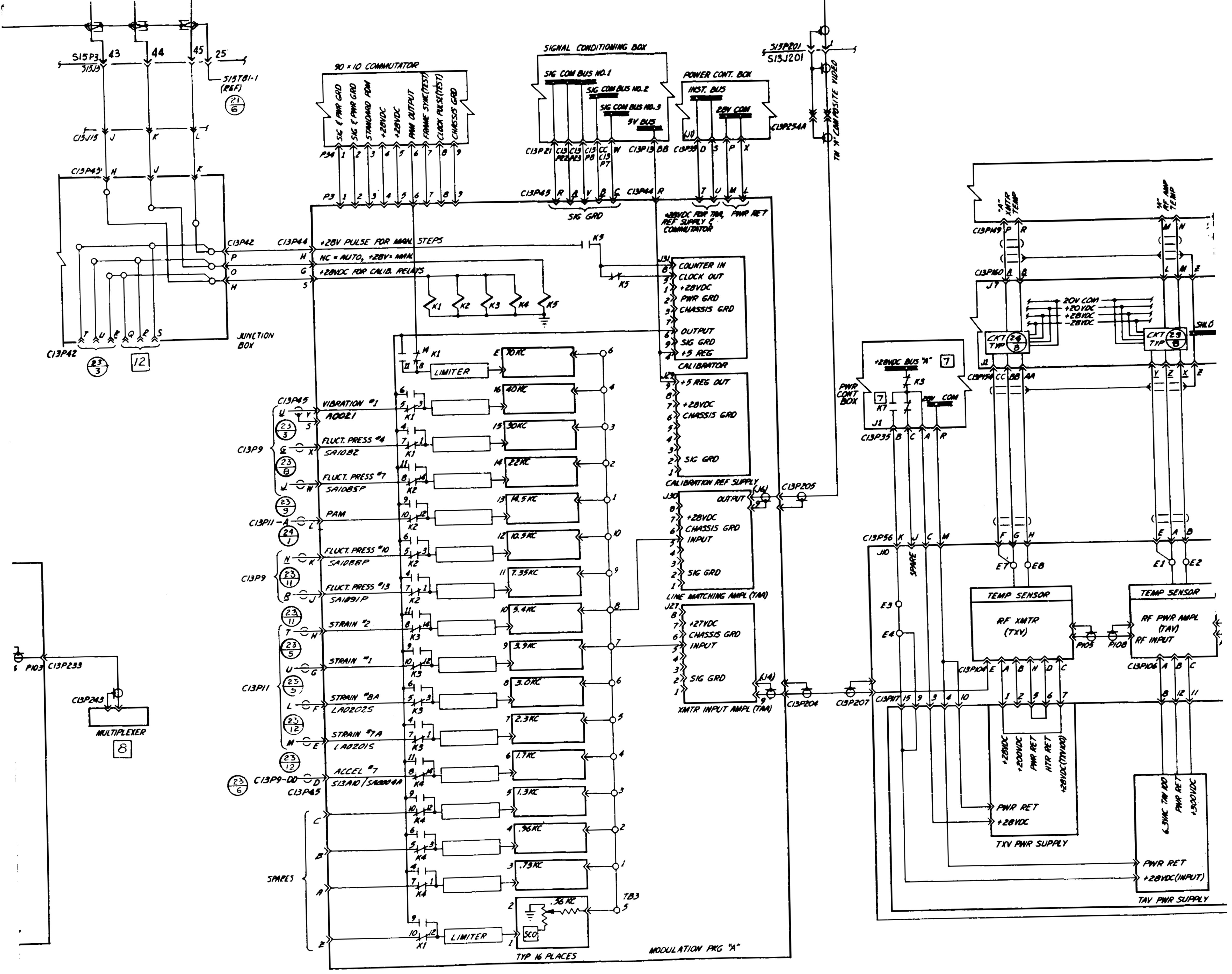
12
11
28VDC PWR GRD
TB1-8
TM B ON
+28VDC BUS
TB1-1
DS12
INSTRUMENT
&
COMMUNICATION
PANEL
C14-419
LAMP
TEST
DS1-14
S9
J1-P
2
J1
G
J
W3030
J6
DATA DISTRIBUTOR
CONSOLE
C14-420
TB10
P/P-D7
TP
D7
J10
W3017
TM GROUND STATION
CABLES TO BE
SUPPLIED BY NASA
J16
TERMINAL
DISTRIBUTOR
C14-131
TB2
TB1
J4
W3040
J9
UMBILICAL J-BOX
C14-132
TB16
TB15
T2
J24
J23
W1004
W1003


10
9
28VDC PWR GRD
TB1-5
TM CALIB ENABLE CONT
TM CALIB MAN CONT
TM CALIB AUTO CONT
+28VDC BUS
TB1-1
DS6
DS8
DS7
LAMP TEST
LAMP TEST DS1-19
S5
S6
S11
OFF
TM CALIB CONTROL MANUAL STEP
J1
W3030
J6
TB11
TB10
P/P-D14
P/P-D12
TP D13
P/P-D13
J10
W3017
TM GROUND STATION
J16
TB4
TB2
TB3
TB1
CABLES TO BE SUPPLIED BY NASA
J4
W3040
TB16
TB28
TB13
TB27
J23
J8
T1
J24
W1003
W1004
2


8
7
R-F SILENCE COMMAND
BEACON ON
RET
DS21
DS14
LAMP TEST
28VDC PWR GRD TB1-5
+28 VDC
+28VDC BUS
XPONDER NO.2 ON
XPONDER NO.1 ON
TM ON
PWR AMP ON
DS2
DS1
DS11
DS3
LAMP TEST S12
BEACON ON
S2
S1
S8
S7
RF XMTR OFF
OFF
ST CONDUCTOR
NEL C14-414
INSTRUMENTATION & COMMUNICATION PANEL C14-414
W3031
W3032
W3030
J1
J2
J7
J19
J6
TB26
TB29
TB10
TB33 (REF)
P/P-D4
TPD4
P/P-D3
TP-D3
P/P D6
TP D6
P/P D5
TP D5
P/P D9
TP D9
P/P ON
TP ON
DATA DISTRIBUTOR CONSOLE C14-420
J10
J12
W3034
OFF
ON
MSFC IND PWR +28VDC
MSFC PATCH & LOGIC DISTR A14-075 SUB UNIT NO. 1
W3017
J16
TB2
TB1
J4
TERMINAL DISTRIBUTOR C14-191
W3040
TB18
TB6
TB16
TB17
TB5
TB15
J22
J23
UMBILICAL J-BOX C14-192
W1002
W1003

3


SIGNAL CONDITIONING BOX
SIG COM BUS NO. 1
SIG COM BUS NO. 2
SIG COM BUS NO. 3
5V BUS
POWER CONT. BOX
INST. BUS
28V COM
SIG GRD
+28VDC FOR TAA E REF SUPPLY
PWR RET
JUNCTION BOX
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MANUAL
+28VDC FOR CALIB RELAYS
COUNTER IN
CLOCK OUT
+28VDC
PWR GRD
CHASSIS GRD
OUTPUT
SIG GRD
+5V REG
CALIBRATOR
+5 REG OUT
CALIBRATION REF SUPPLY
INPUT
LINE MATCHING AMPL (TAA)
XMTR INPUT AMPL (TAA)
FLUCT. PRESS #1
CA0179P
LIMITER
70 KC
VIBRATION #4
SA0028BD
52.5 KC
STRAIN GAGE
SA212 05
40 KC
FLUCT. PRESS #3
A01P1
30 KC
FLUCT. PRESS #6
SA1084P
22 KC
FLUCT. PRESS #9
SA1087P
14.5 KC
FLUCT. PRESS #12
SA1090P
10.5 KC
FLUCT. PRESS #15
A0193P
7.35 KC
STRAIN #3
5.4 KC
STRAIN #6A
LA0200S
3.9 KC
ACCEL #1
E13A1/A0011
3.0 KC
ACCEL #2
E13A1/A0012
2.3 KC
ACCEL #4
C13A6/CA0007A
1.7 KC
1.3 KC
.96 KC
.73 KC
SPARES
SCO
TYP 16 PLACES
TB3
MODULATION PKG "B"
TM "B" COMPOSITE VIDEO
TM "B" RF
XMTR CONT
90 x 1¼ LOW LEVEL COMMUTATOR
"B" XMTR TEMP
"B" RF AMP TEMP
20V COM
+20VDC
+28VDC
-28VDC
SHLD COM BUS
CKT TYP
SIGNAL CONDITIONING BOX TMS 1090
+28V BUS "A"
COM
TEMP SENSOR
RF XMTR (TXV)
RF PWR AMPL (TAV)
RF INPUT
BAND PASS FILTER
IN
OUT
+28VDC
+200VDC
PWR RET
HTR RET
+28VDC (TXV 100)
TXV PWR SUPPLY
6.3 VAC TAV 100
+300VDC
+28VDC (INPUT)
TAV PWR SUPPLY
RF PACKAGE "B"


90 × 10 COMMUTATOR
SIG & PWR GRD
STANDARD PDM
+28VDC
PAM OUTPUT
FRAME SYNC (TEST)
CLOCK PULSE (TEST)
CHASSIS GRD
SIGNAL CONDITIONING BOX
SIG COM BUS NO. 1
SIG COM BUS NO. 2
SIG COM BUS NO. 3
5V BUS
POWER CONT. BOX
INST. BUS
28V COM
TM "A" COMPOSITE VIDEO
SIG GRD
PWR RET
+28VDC FOR TAA, REF SUPPLY & COMMUTATOR
JUNCTION BOX
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MAN.
+28VDC FOR CALIB. RELAYS
COUNTER IN
CLOCK OUT
PWR GRD
OUTPUT
+5 REG
CALIBRATOR
+5 REG OUT
CALIBRATION REF SUPPLY
INPUT
LINE MATCHING AMPL (TAA)
+27VDC
XMTR INPUT AMPL (TAA)
LIMITER
70KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC
.73KC
.56KC
SCO
TYP 16 PLACES
MODULATION PKG "A"
TB3
VIBRATION #1
A002I
FLUCT. PRESS #4
SA10BZ
FLUCT. PRESS #7
SA10BSP
PAM
FLUCT. PRESS #10
SA10BBP
FLUCT. PRESS #13
SA1B91P
STRAIN #2
STRAIN #1
STRAIN #8A
LA02025
STRAIN #7A
LA02015
ACCEL #7
S13A10/SA0804A
SPARES
MULTIPLEXER
+28VDC BUS "A"
PWR CONT BOX
"A" XMTR TEMP
"A" RF AMP TEMP
20V COM
+20VDC
+28VDC
-28VDC
CKT TYP
SHLD
SPARE
TEMP SENSOR
RF XMTR (TXV)
RF PWR AMPL (TAV)
RF INPUT
+200VDC
HTR RET
+28VDC (TRIAD)
TXV PWR SUPPLY
6.3VAC TM 100
+300VDC
+28VDC (INPUT)
TAV PWR SUPPLY

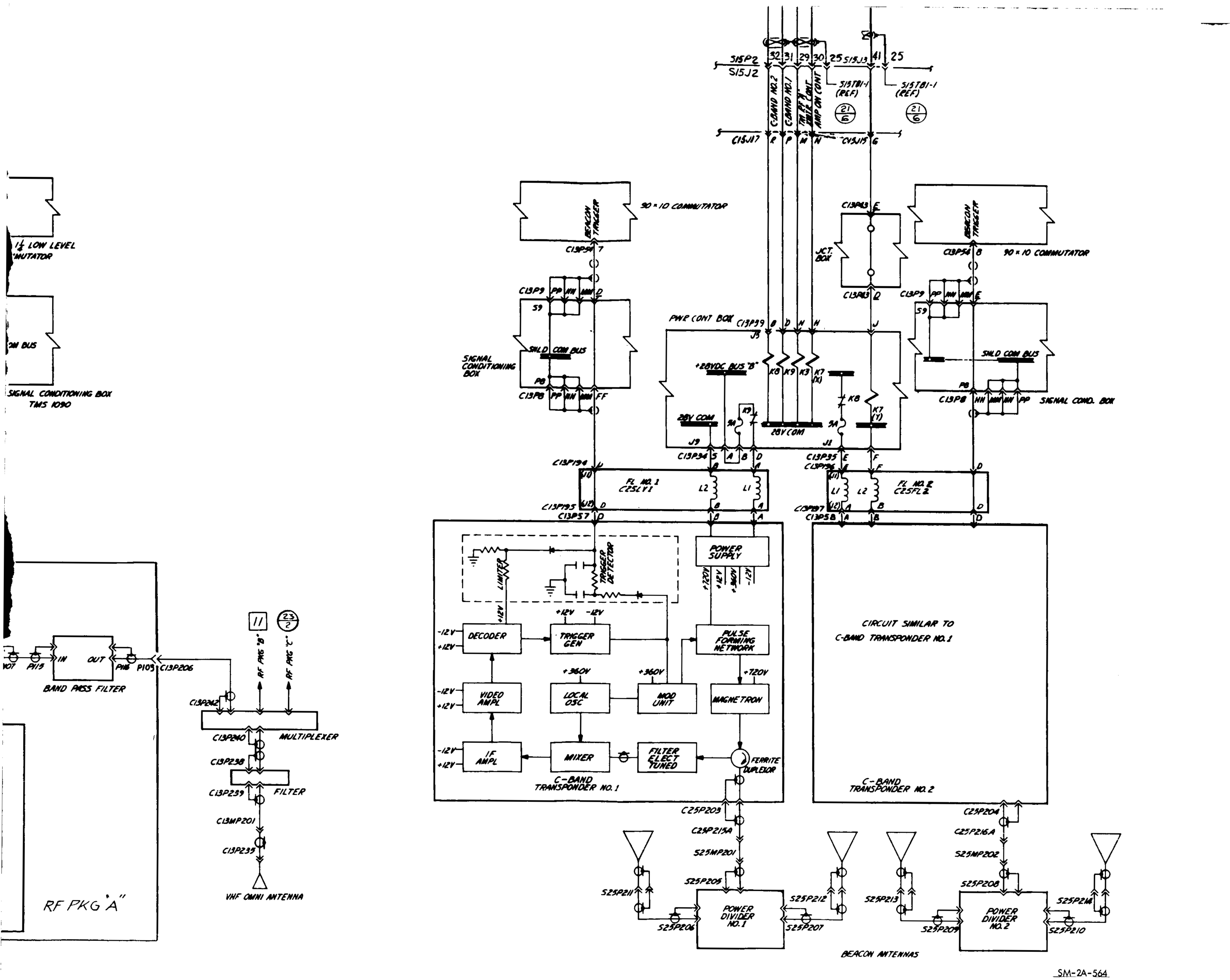
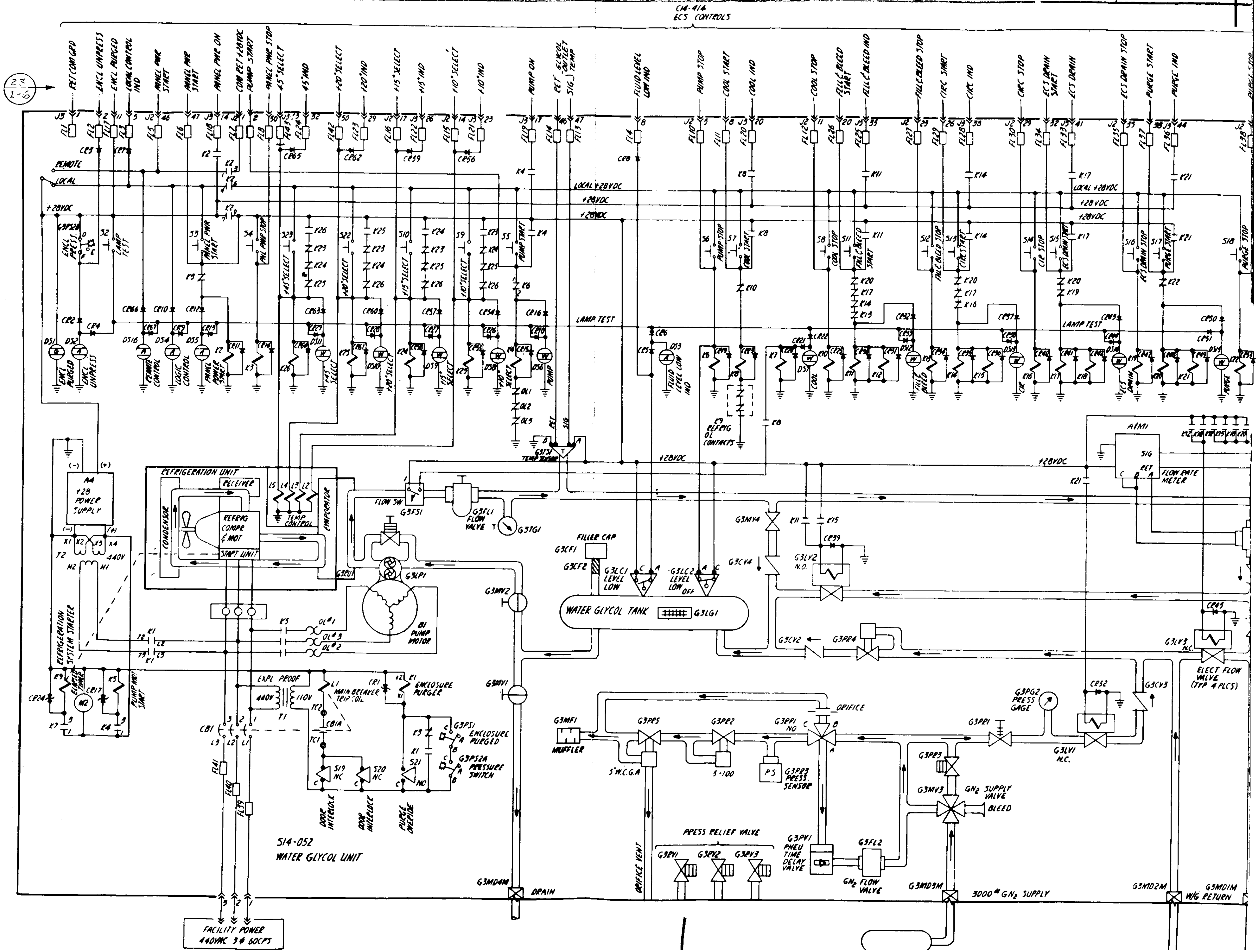


Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 5 of 5)

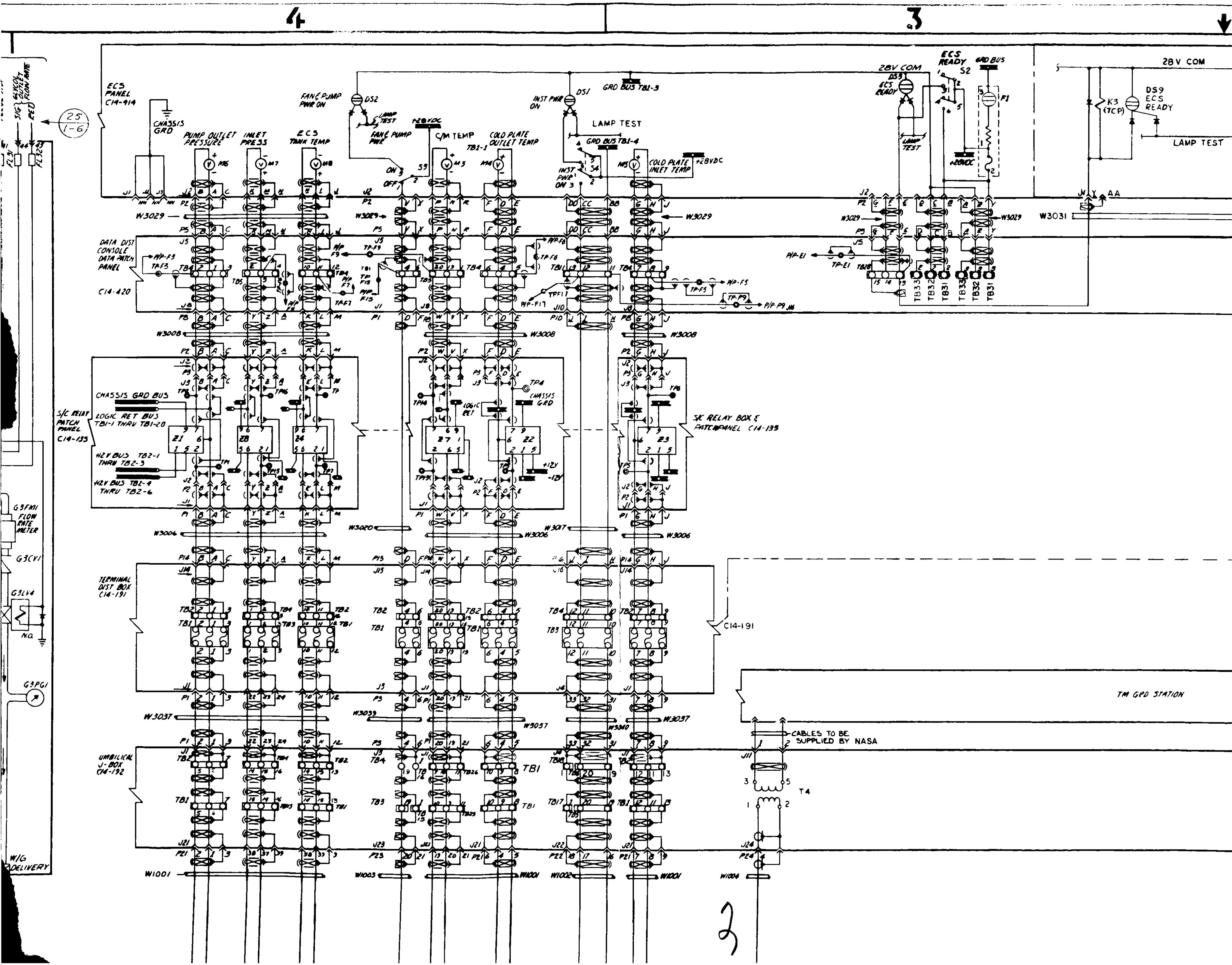
6

6

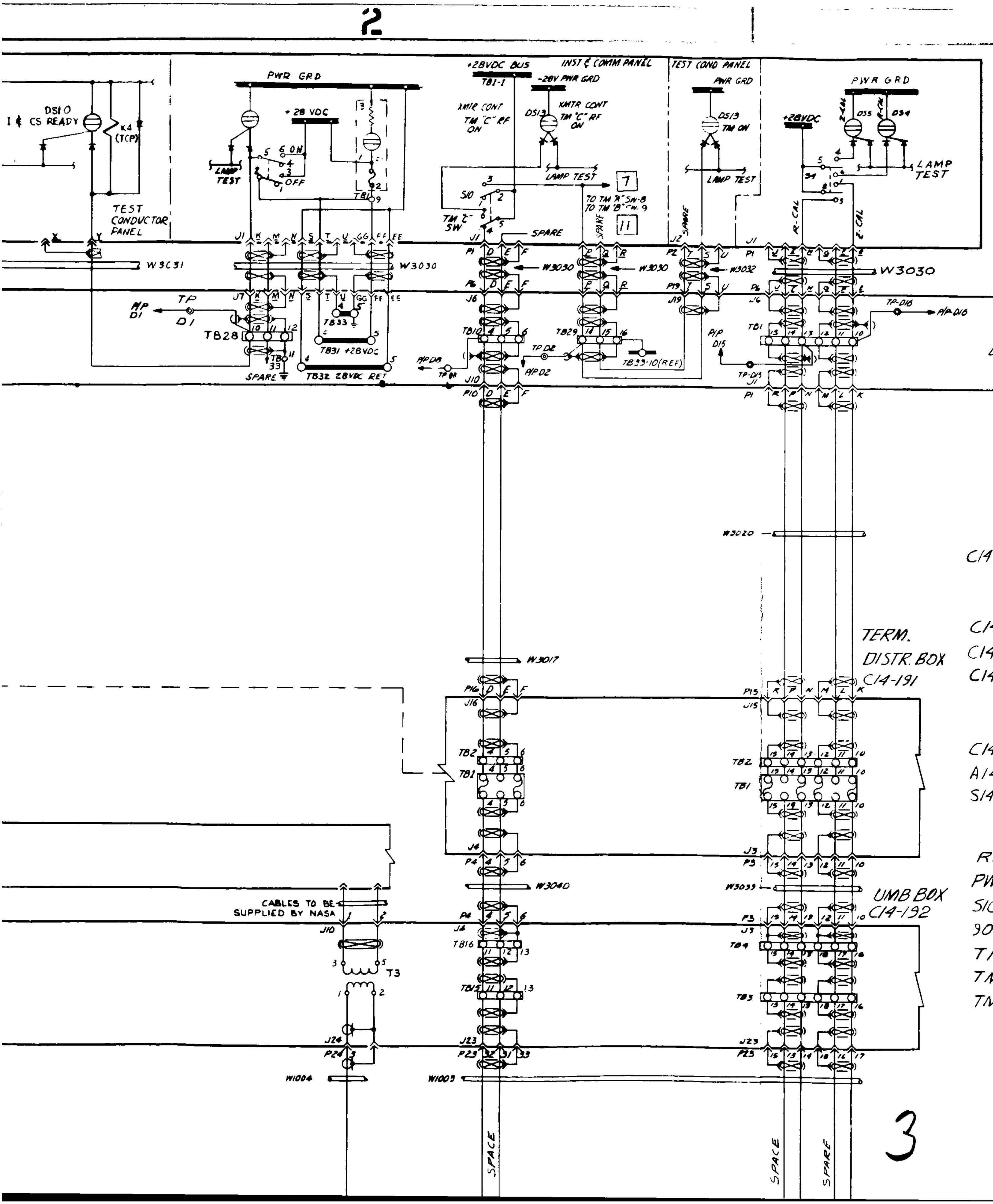
5



CI4-414
ECS CONTROLS
REFRIGERATION UNIT
RECEIVER
CONDENSOR
EVAPORATOR
REFRIG COMPR & MOT
START UNIT
TEMP CONTROL
A4 +28 POWER SUPPLY
REFRIGERATION SYSTEM STARTER
FLOW SW
G3FS1
G3FL1 FLOW VALVE
G3TG1
G3LP1
B1 PUMP MOTOR
FILLER CAP
WATER GLYCOL TANK
G3LG1
G3LC1 LEVEL LOW
G3LC2 LEVEL LOW
A1M1
FLOW RATE METER
G3LV2 N.O.
G3LV3 N.C.
ELECT FLOW VALVE (TYP 4 PLCS)
EXPL PROOF
MAIN BREAKER TRIP COIL
ENCLOSURE PURGER
ENCLOSURE PURGED
PRESSURE SWITCH
DOOR INTERLOCK
PURGE OVERIDE
ORIFICE
G3PG2 PRESS GAGE
MUFFLER
G3PS3 PRESS. SENSOR
G3PV1 PNEU TIME DELAY VALVE
GN2 FLOW VALVE
GN2 SUPPLY VALVE
BLEED
PRESS RELIEF VALVE
ORIFICE VENT
DRAIN
3000# GN2 SUPPLY
W/G RETURN
514-052
WATER GLYCOL UNIT
FACILITY POWER
440VAC 3Ø 60CPS



4
3
ECS PANEL C14-414
CHASSIS GRD
PUMP OUTLET PRESSURE
INLET PRESS
ECS TANK TEMP
FAN & PUMP PWR ON
DS2
LAMP TEST
FAN & PUMP PWR
+28VDC
C/M TEMP
COLD PLATE OUTLET TEMP
INST PWR ON
DS1
GRD BUS TB1-3
LAMP TEST
GRD BUS TB1-4
COLD PLATE INLET TEMP
+28VDC
28V COM
ECS READY
S2
GRD BUS
DS3
F1
28V COM
K3 (TCP)
DS9 ECS READY
LAMP TEST
W3029
W3031
DATA DIST CONSOLE DATA PATCH PANEL
C14-420
W3008
CHASSIS GRD BUS
LOGIC RET BUS TB1-1 THRU TB1-20
S/C RELAY PATCH PANEL C14-133
H2V BUS TB2-1 THRU TB2-3
H2V BUS TB2-4 THRU TB2-6
S/C RELAY BOX & PATCHPANEL C14-133
W3006
W3020
W3017
TERMINAL DIST BOX C14-191
C14-191
TM GRD STATION
W3037
W3039
UMBILICAL J-BOX C14-192
CABLES TO BE SUPPLIED BY NASA
T4
W1001
W1003
W1002
W1004
G3FM1 FLOW RATE METER
G3CV1
G3LV4
G3PG1
W/G DELIVERY
GLYCOL OUTLET FLOW RATE
25
1-6
2



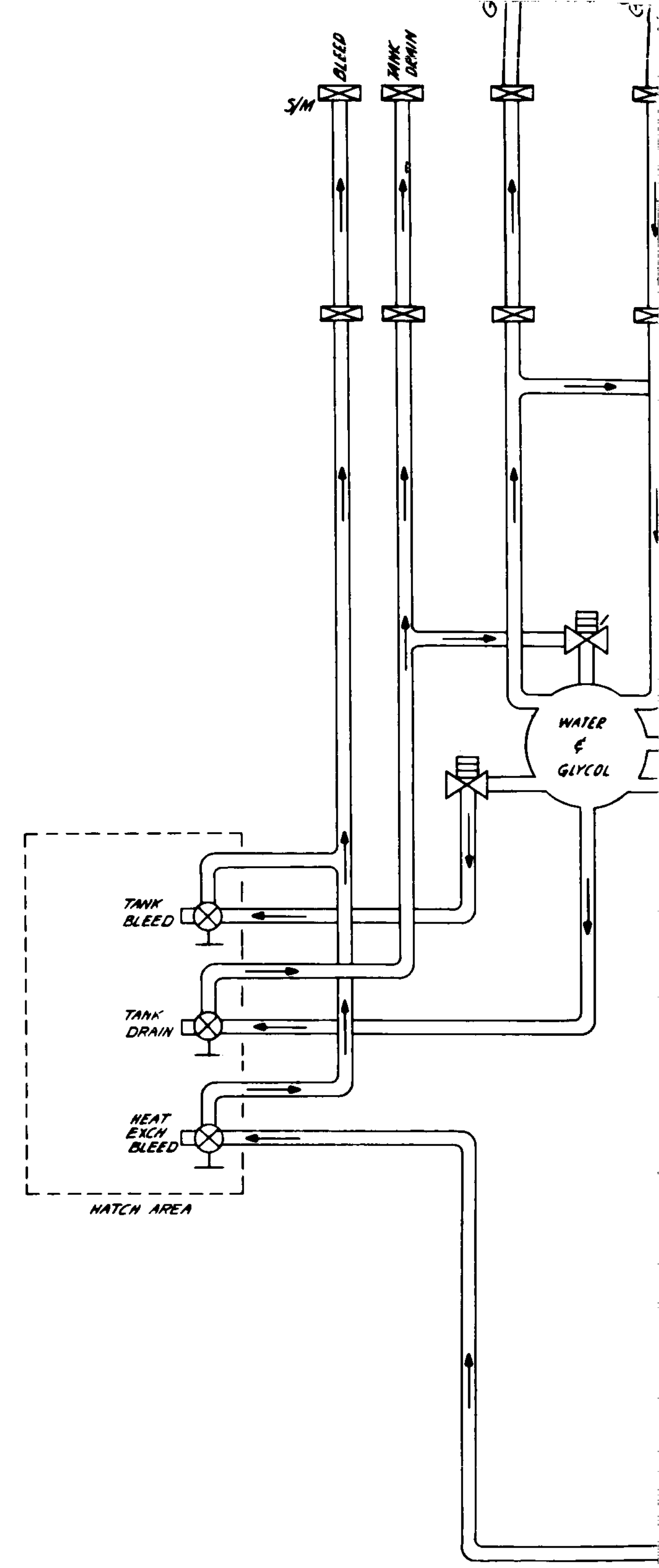
RELATED DRAWINGS

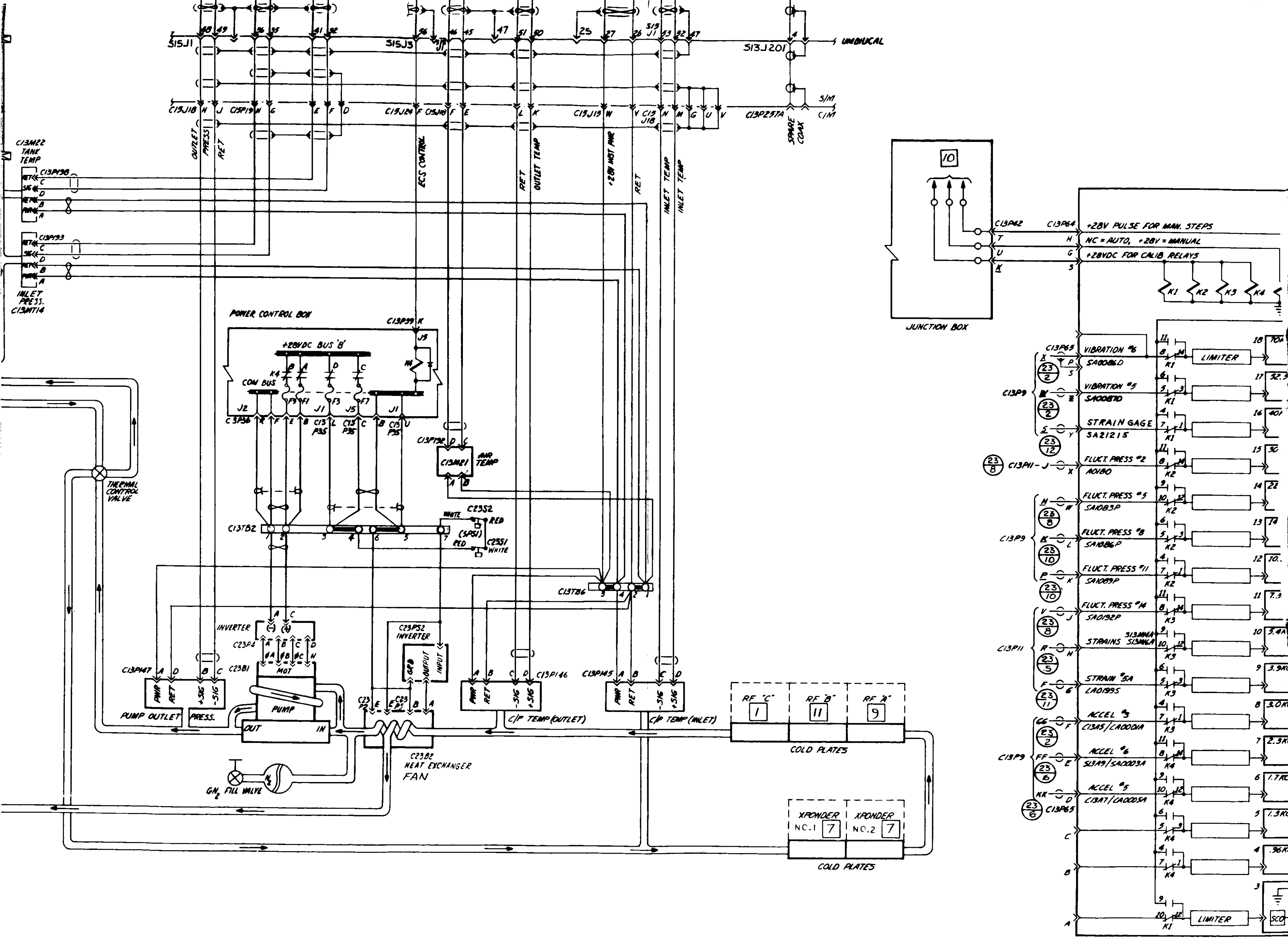
UNIT	SCHEMATIC GSE	WIRING DIAGRAM
C14-414 (TCP)	G16-985132A	G16-853953A
(INST & COMM)	G16-985133	G16-853693
(ECS PNL)	G16-985134B	G16-853973A
C14-420 (DATA DIST)	G16-985158	G16-850533
C14-135 (RELAY BOX)	G16-985128A	G16-582563
C14-191 (TERM. DIST)	————	G16-851308 THRU G16-851315 AND G16-851318
C14-192 (UMB. J-BOX)	————	G16-852857
A14-075 (SMFC)	G16-985363A	G16-853067A
S14-052 (WATER GLYCOL)	G16-984812A	

BOILERPLATE

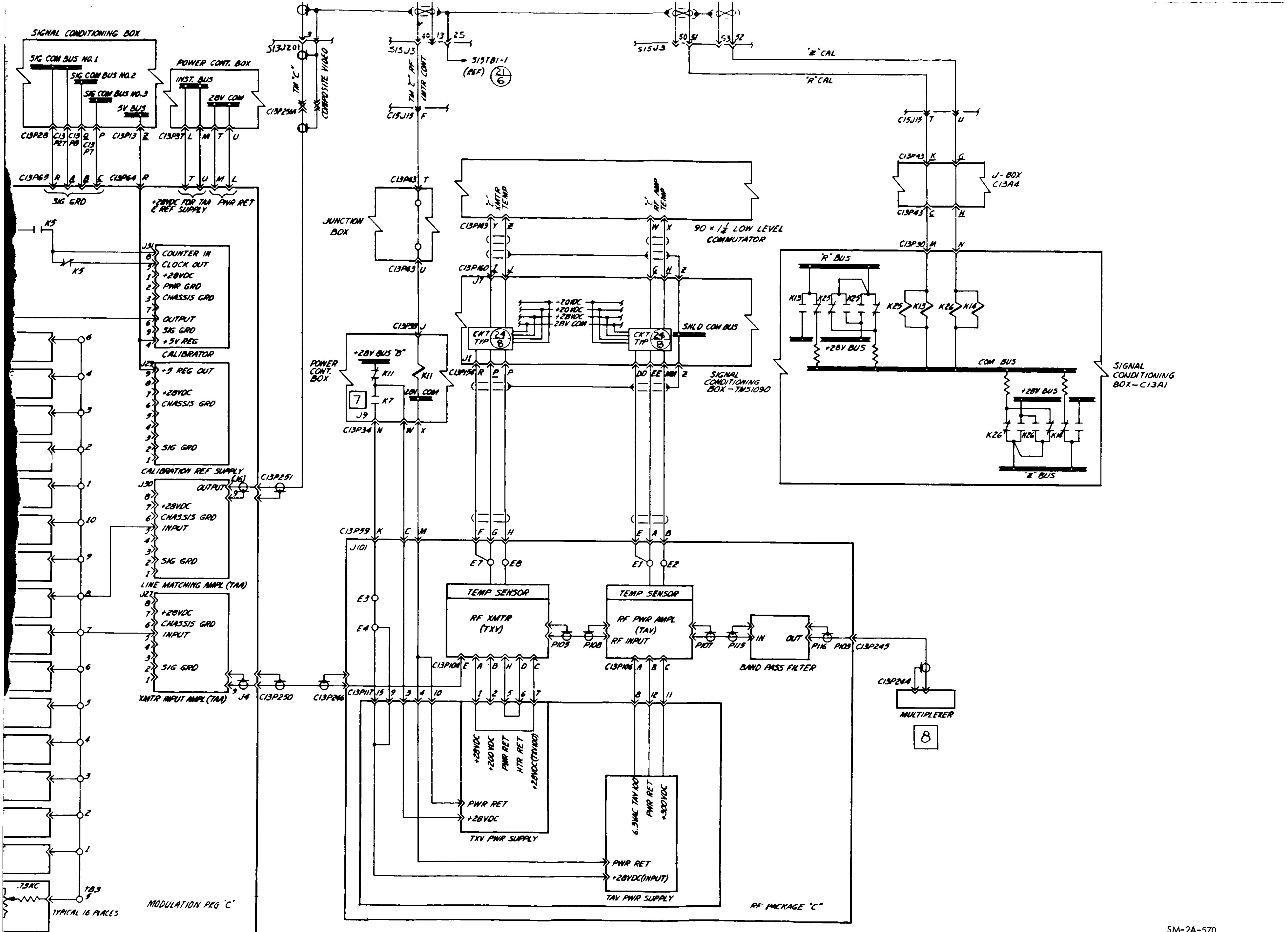
RELAY BOX	B17-450221B
PWR CONT BOX	SX540,007 (NASA)
SIG COND BOX	SX530,106 (NASA)
90 X 1¼ COMM (SIG W/D)	SX530,057 (NASA)
TM R-F PKG	SD530,136 (NASA)
TM MOD PKG "A"	SX530,135 (NASA)
TM MOD PKG "B" & "C"	SX530,097 (NASA)

RELAY NO.	NO. OF POLES	ZONE LOCATION	
		COILS	POLES
K1	3	6	6
K2	4	6	6
K3	2	6	6
K4	3	6	6
K5	3	6	6
K6	1	5	6
K7	1	5	6
K8	3	5	5
K9	2	6	5
K10	1	5	5
K11	3	5	5
K12	2	5	5
K13	1	5	5
K14	3	5	5
K15	2	5	5
K16	1	5	5
K17	4	5	5
K18	2	5	4, 5
K19	1	5	5
K20	4	5	4, 5
K21	3	5	5
K22	1	4	5
K23	4	6	6
K24	4	6	6
K25	4	6	6
K26	4	6	6





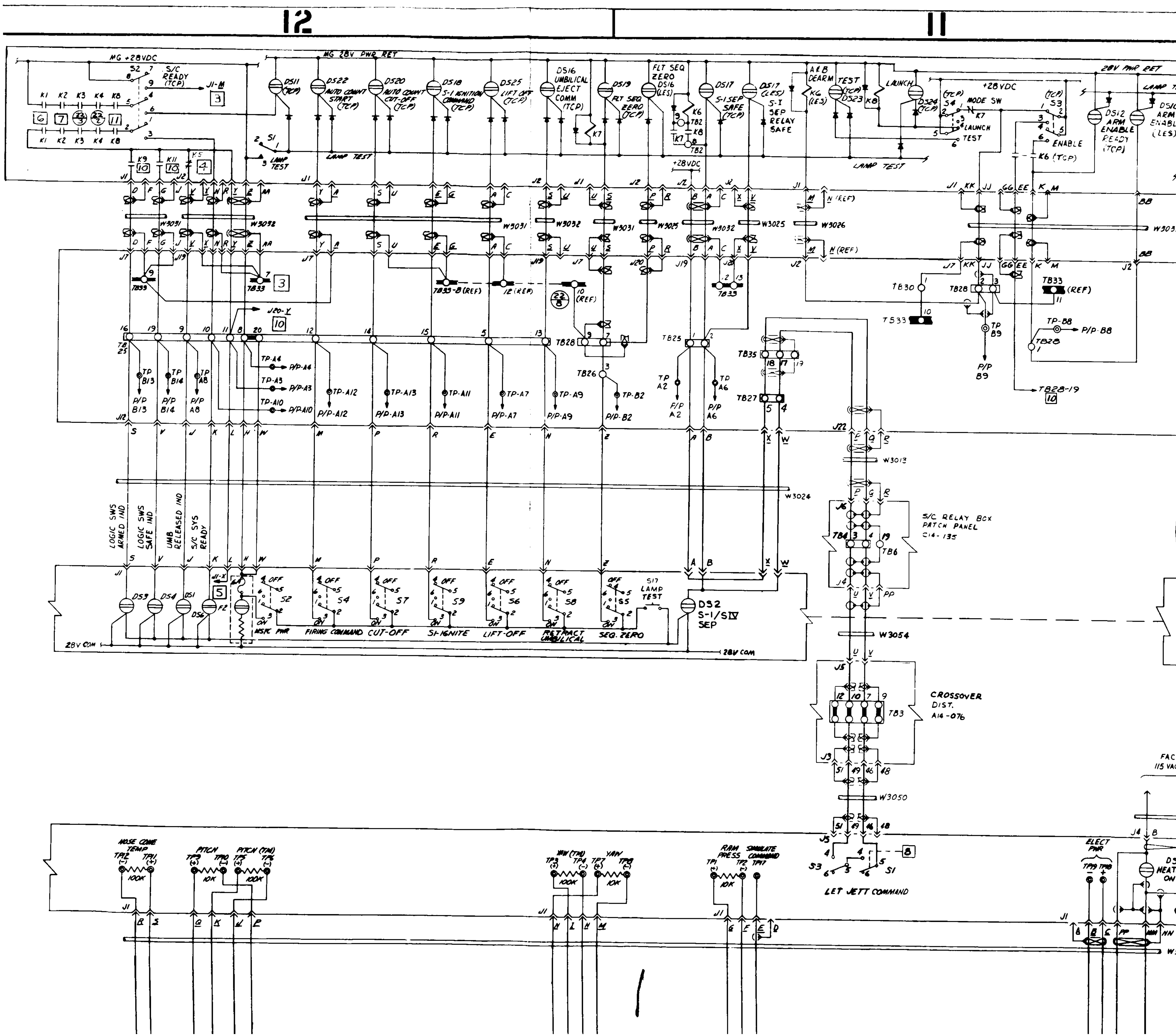
UMBILICAL
S13J201
S15J1
S15J3
C15J18
C15P19
C15J24
C13P257A
SPARE COAX
OUTLET PRESS
RET
ECS CONTROL
OUTLET TEMP
+28V HOT PWR
INLET TEMP
C13M22 TANK TEMP
INLET PRESS. C13MT14
JUNCTION BOX
10
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MANUAL
+28VDC FOR CALIB. RELAYS
POWER CONTROL BOX
+28VDC BUS 'B'
COM BUS
C13M21 AIR TEMP
C13TB2
C13TB6
INVERTER
C23P4
C23B1
MOT
PUMP
OUT
IN
C23PS2 INVERTER
INPUT
OUTPUT
GRD
C13P147
PUMP OUTLET
PRESS.
C13P146
C/P TEMP (OUTLET)
C13P145
C/P TEMP (INLET)
THERMAL CONTROL VALVE
C23B2 HEAT EXCHANGER FAN
GN2 FILL VALVE
RF "C"
RF "B"
RF "A"
COLD PLATES
XPONDER NO.1
XPONDER NO.2
VIBRATION #6
SA0086D
VIBRATION #5
SA0087D
STRAIN GAGE
SA21215
FLUCT. PRESS #2
A0180
FLUCT. PRESS #5
SA1083P
FLUCT. PRESS #8
SA1086P
FLUCT. PRESS #11
SA1089P
FLUCT. PRESS #14
SA0192P
STRAINS
STRAIN #5A
LA0199S
ACCEL #3
C13A5/CA0001A
ACCEL #6
S13A9/SA0003A
ACCEL #5
C13A7/CA0005A
LIMITER
C13P9
C13P11
C13P65

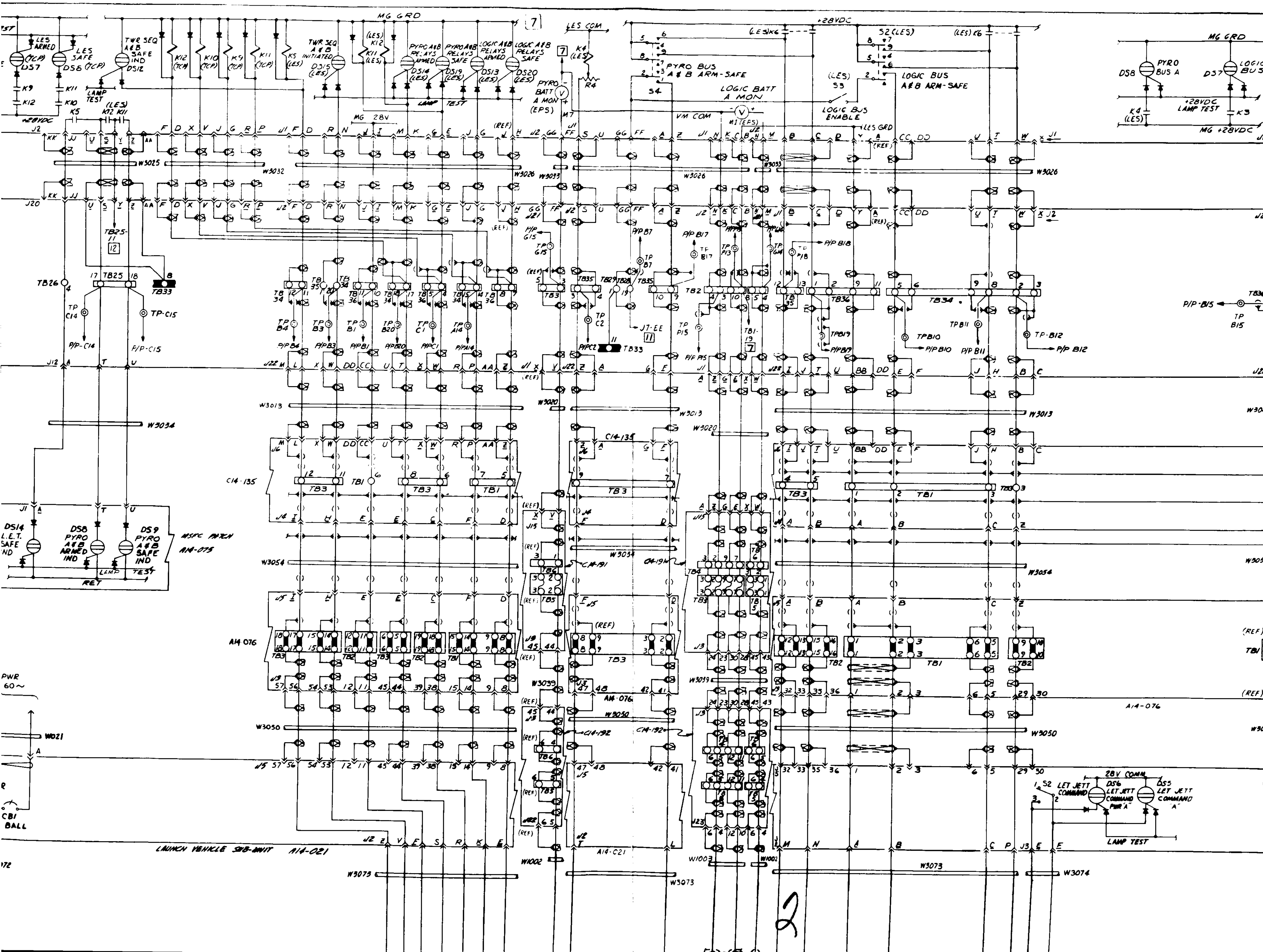


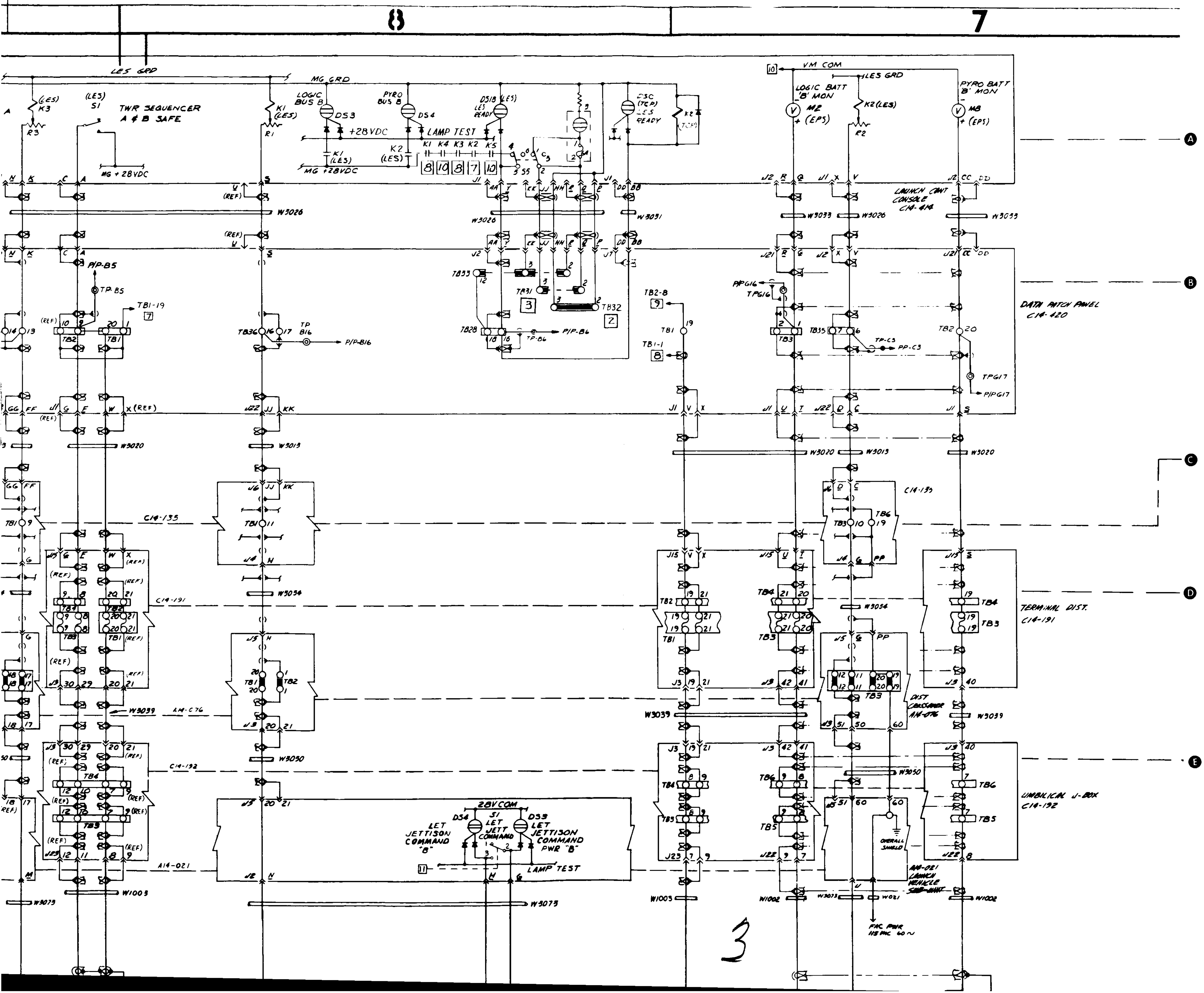
SM-2A-570

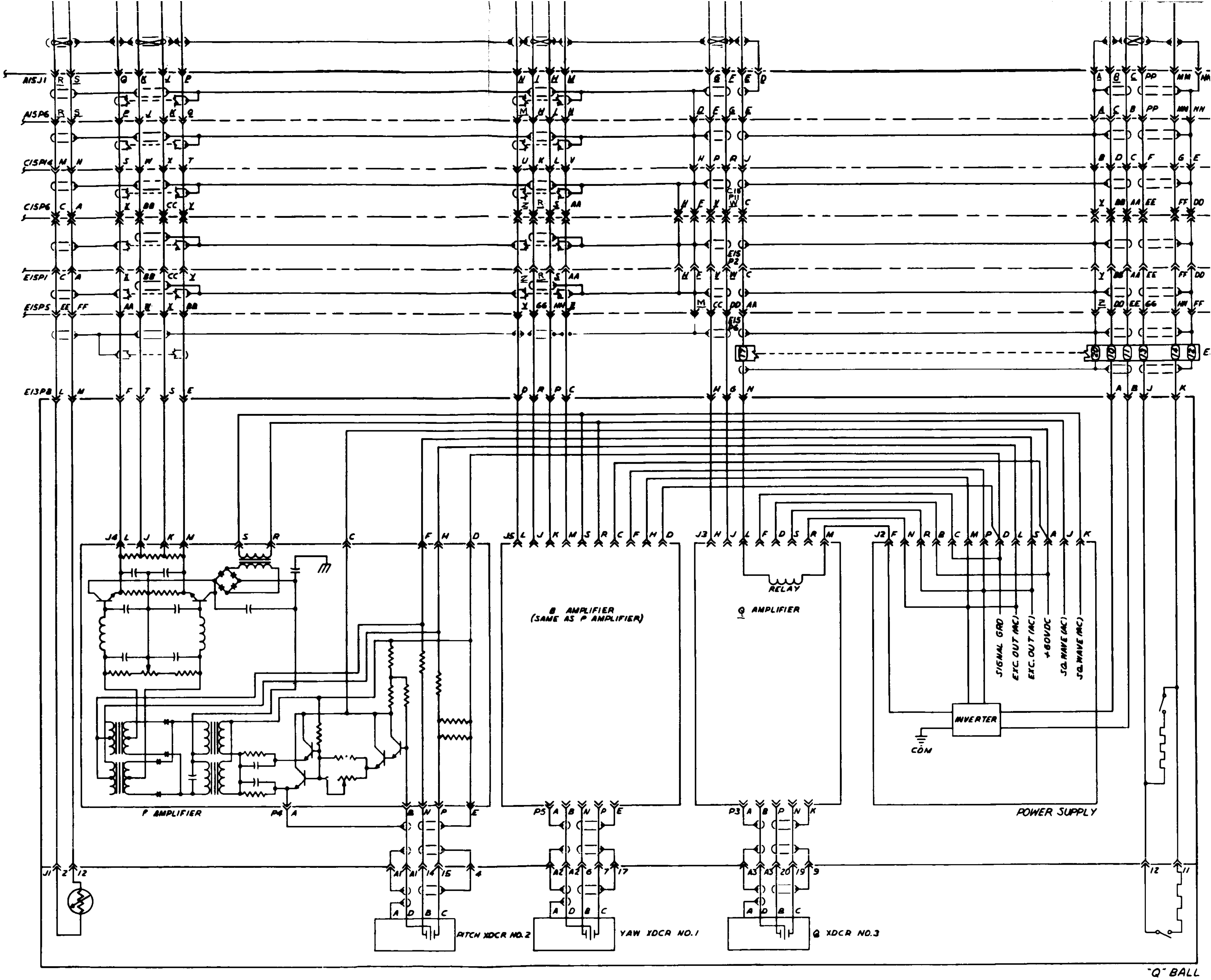
Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 6 of 8)

6

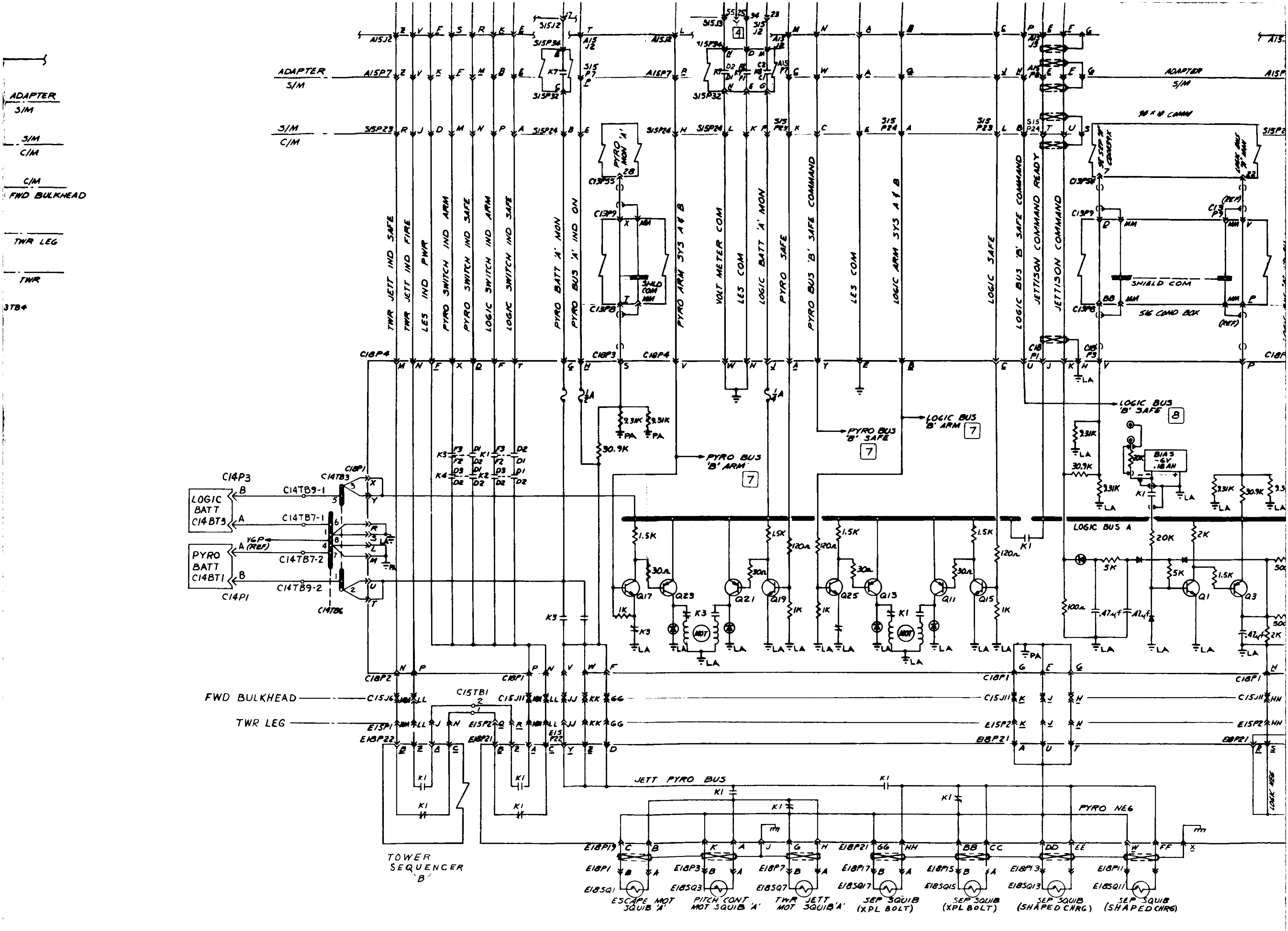

12
11
MG +28VDC
MG 28V PWR RET
S/C READY (TCP)
J1-M
LAMP TEST
DS11 (TCP)
DS22 AUTO COUNT START (TCP)
DS20 AUTO COUNT CUT-OFF (TCP)
DS18 S-I IGNITION COMMAND (TCP)
DS25 LIFT OFF (TCP)
DS16 UMBILICAL EJECT COMM (TCP)
DS19 FLT SEQ ZERO (TCP)
FLT SEQ ZERO DS16 (LES)
DS17 S-I SEP SAFE (TCP)
DS17 (LES) S-I SEP RELAY SAFE
A&B DEARM
TEST
DS23
LAUNCH
DS24 (TCP)
+28VDC
MODE SW
LAUNCH
TEST
ENABLE
K6 (TCP)
DS12 ARM ENABLE READY (TCP)
ARM ENABLE (LES)
28V PWR RET
W3031
W3032
W3025
W3026
N (REF)
TB33 (REF)
TB28-19
W3024
W3013
S/C RELAY BOX PATCH PANEL C14-135
LOGIC SWS ARMED IND
LOGIC SWS SAFE IND
UMB RELEASED IND
S/C SYS READY
OFF
ON
MSTC PWR
FIRING COMMAND
CUT-OFF
SI-IGNITE
LIFT-OFF
RETRACT UMBILICAL
SEQ. ZERO
S17 LAMP TEST
DS2 S-I/SIV SEP
28V COM
W3054
CROSSOVER DIST. A14-076
W3050
NOSE CONE TEMP
PITCH
PITCH (TM)
YAW (TM)
YAW
RAM PRESS
SIMULATE COMMAND
100K
10K
LET JETT COMMAND
ELECT PWR


MG GRD
+28VDC
LES COM
PYRO BUS A & B ARM-SAFE
LOGIC BUS A & B ARM-SAFE
LOGIC BATT A MON
LOGIC BUS ENABLE
PYRO BATT A MON (EPS)
VM COM
LAMP TEST
TWR SEQ A & B SAFE IND
TWR SEQ A & B INITIATED
PYRO A & B RELAYS ARMED
PYRO A & B RELAYS SAFE
LOGIC A & B RELAYS ARMED
LOGIC A & B RELAYS SAFE
LES ARMED
LES SAFE
PYRO BUS A
+28VDC LAMP TEST
MG +28VDC
MSFC PATCH A14-075
DS14 L.E.T. SAFE IND
DS8 PYRO A & B ARMED IND
DS9 PYRO A & B SAFE IND
RET
A14 076
A14-076
A14-C21
LAUNCH VEHICLE SUB-UNIT A14-021
28V COMM
LET JETT COMMAND
LET JETT COMMAND PWR 'A'
LET JETT COMMAND 'A'
W3025
W3026
W3013
W3054
W3050
W3073
W3074
2

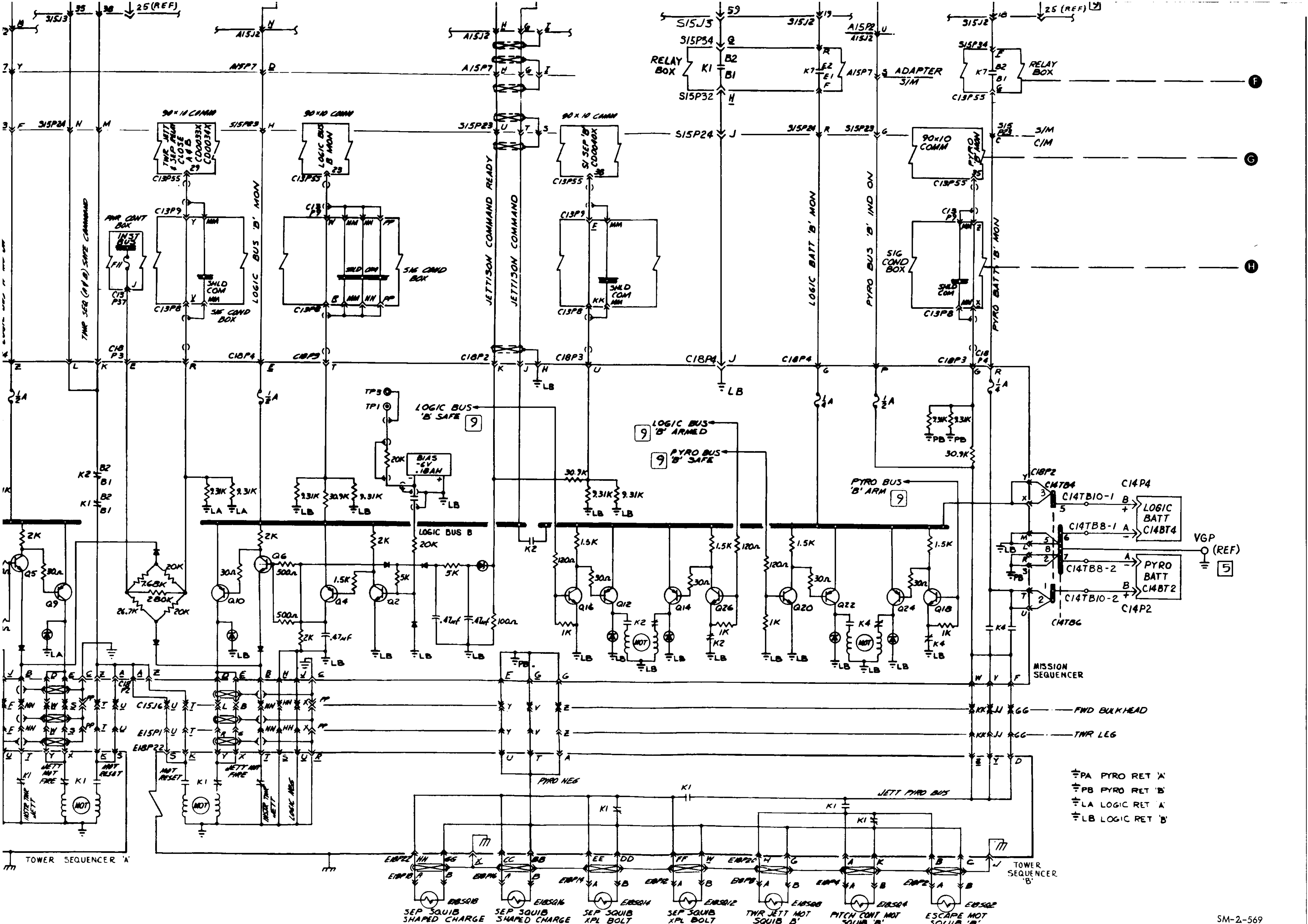

8
7
LES GRD
MG GRD
TWR SEQUENCER A & B SAFE
LOGIC BUS B
PYRO BUS B
LAMP TEST
+28VDC
MG +28VDC
VM COM
LOGIC BATT 'B' MON
PYRO BATT 'B' MON
LAUNCH CONT CONSOLE C14-414
DATA PATCH PANEL C14-420
C14-135
TERMINAL DIST. C14-191
C14-192
UMBILICAL J-BOX C14-192
A14-021
28V COM
LET JETTISON COMMAND "B"
LET JETT COMMAND
LET JETTISON COMMAND PWR "B"
W3026
W3020
W3013
W3054
W3039
W3050
W1003
W3073
W1002
FAC PWR 115 VAC 60 ~
3


P AMPLIFIER
B AMPLIFIER (SAME AS P AMPLIFIER)
Q AMPLIFIER
RELAY
POWER SUPPLY
INVERTER
SIGNAL GRD
EXC. OUT (AC)
EXC. OUT (AC)
+80VDC
SQ. WAVE (AC)
SQ. WAVE (AC)
COM
PITCH XDCR NO. 2
YAW XDCR NO. 1
Q XDCR NO. 3
"Q" BALL

4



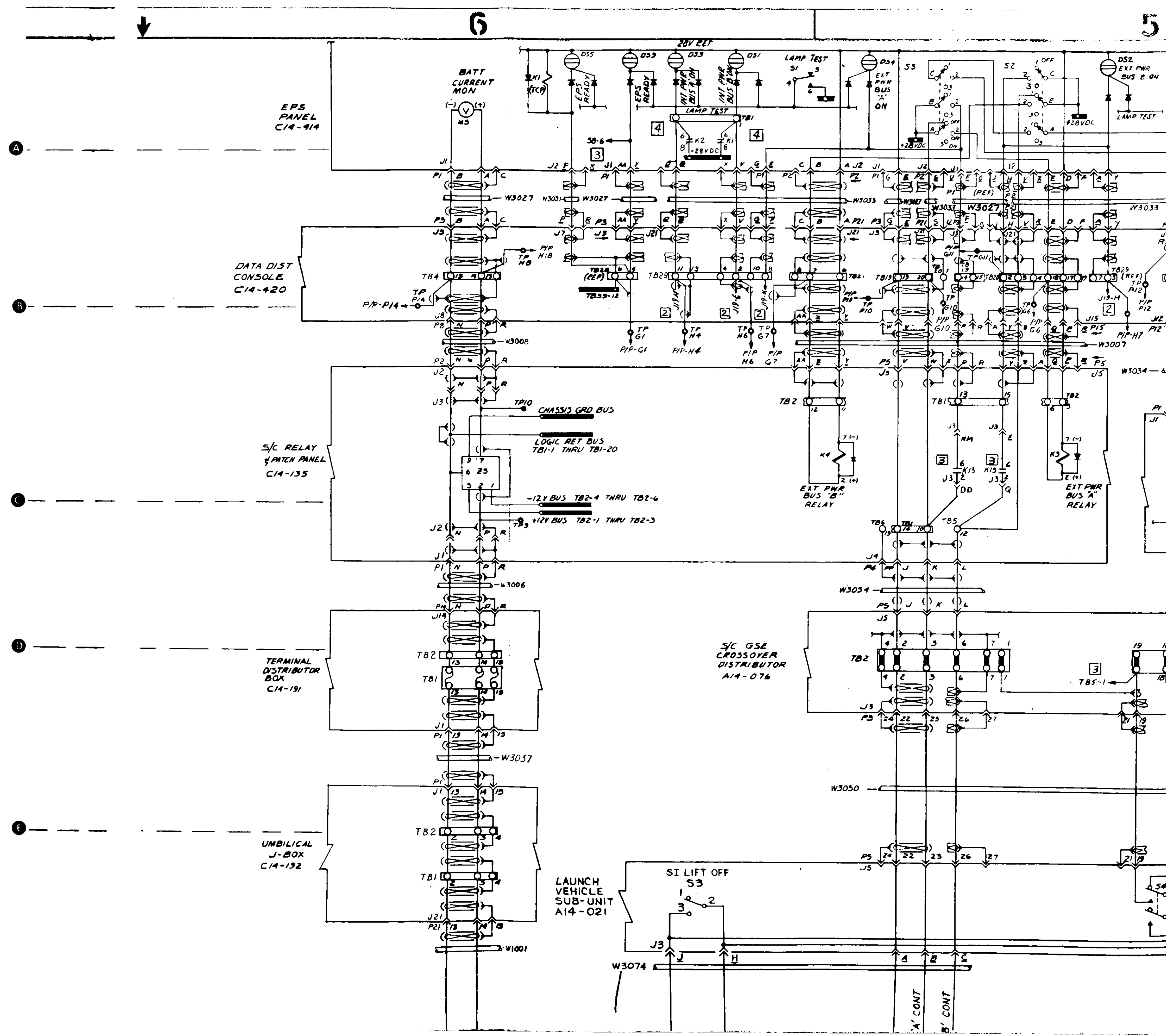
ADAPTER
S/M
C/M
FWD BULKHEAD
TWR LEG
TWR
TWR JETT IND SAFE
TWR JETT IND FIRE
LES IND PWR
PYRO SWITCH IND ARM
PYRO SWITCH IND SAFE
LOGIC SWITCH IND ARM
LOGIC SWITCH IND SAFE
PYRO BATT 'A' MON
PYRO BUS 'A' IND ON
PYRO ARM SYS A & B
VOLT METER COM
LES COM
LOGIC BATT 'A' MON
PYRO SAFE
PYRO BUS 'B' SAFE COMMAND
LOGIC ARM SYS A & B
LOGIC SAFE
LOGIC BUS 'B' SAFE COMMAND
JETTISON COMMAND READY
JETTISON COMMAND
SHIELD COM
LOGIC BUS 'B' SAFE
PYRO BUS 'B' SAFE
LOGIC BUS 'B' ARM
PYRO BUS 'B' ARM
LOGIC BUS A
LOGIC BATT C14BT3
PYRO BATT C14BT1
C14P3
C14P1
JETT PYRO BUS
PYRO NEG
TOWER SEQUENCER 'B'
ESCAPE MOT SQUIB 'A'
PITCH CONT MOT SQUIB 'A'
TWR JETT MOT SQUIB 'A'
SEP SQUIB (XPL BOLT)
SEP SQUIB (XPL BOLT)
SEP SQUIB (SHAPED CHRG)
SEP SQUIB (SHAPED CHRG)



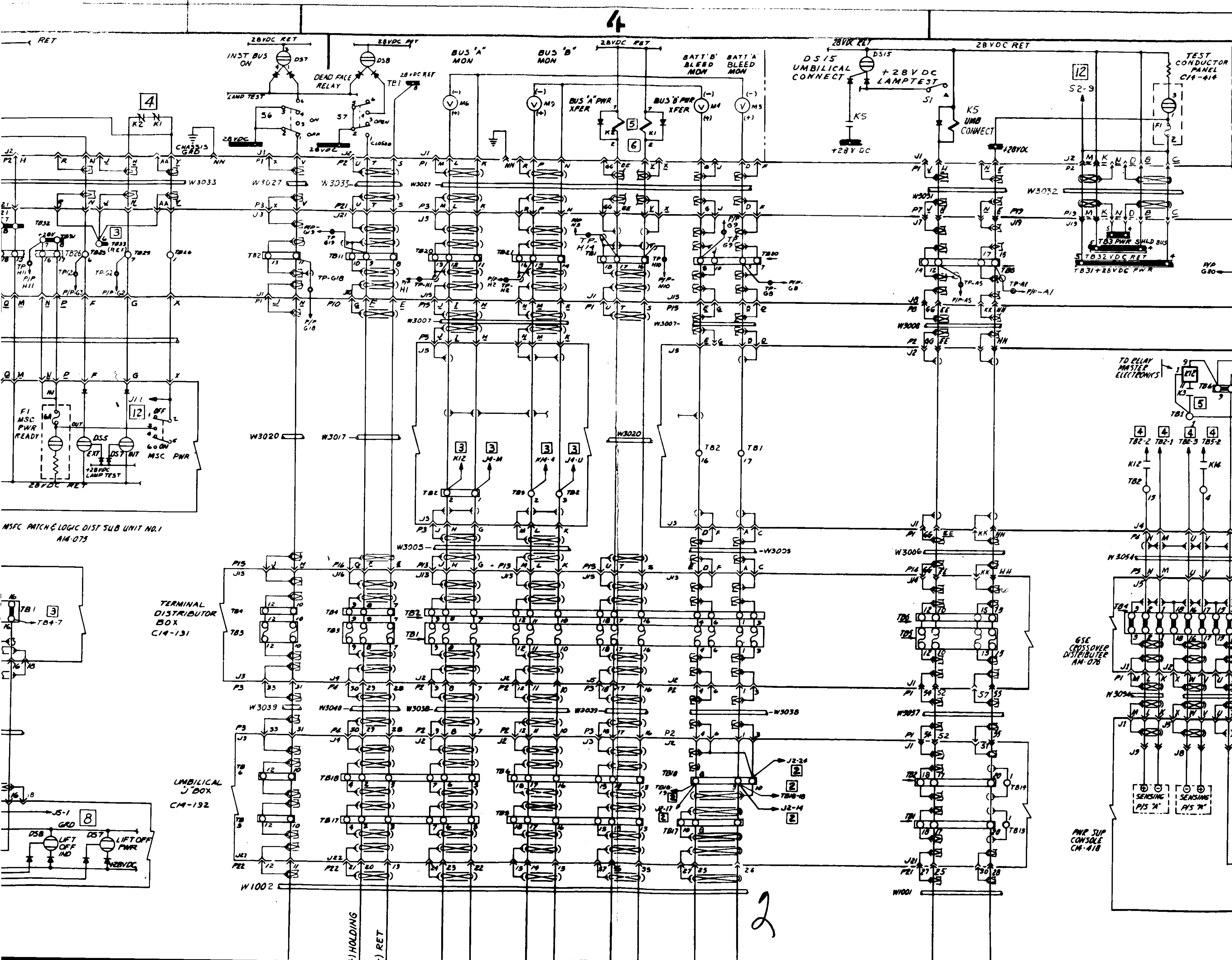
SM-2-569

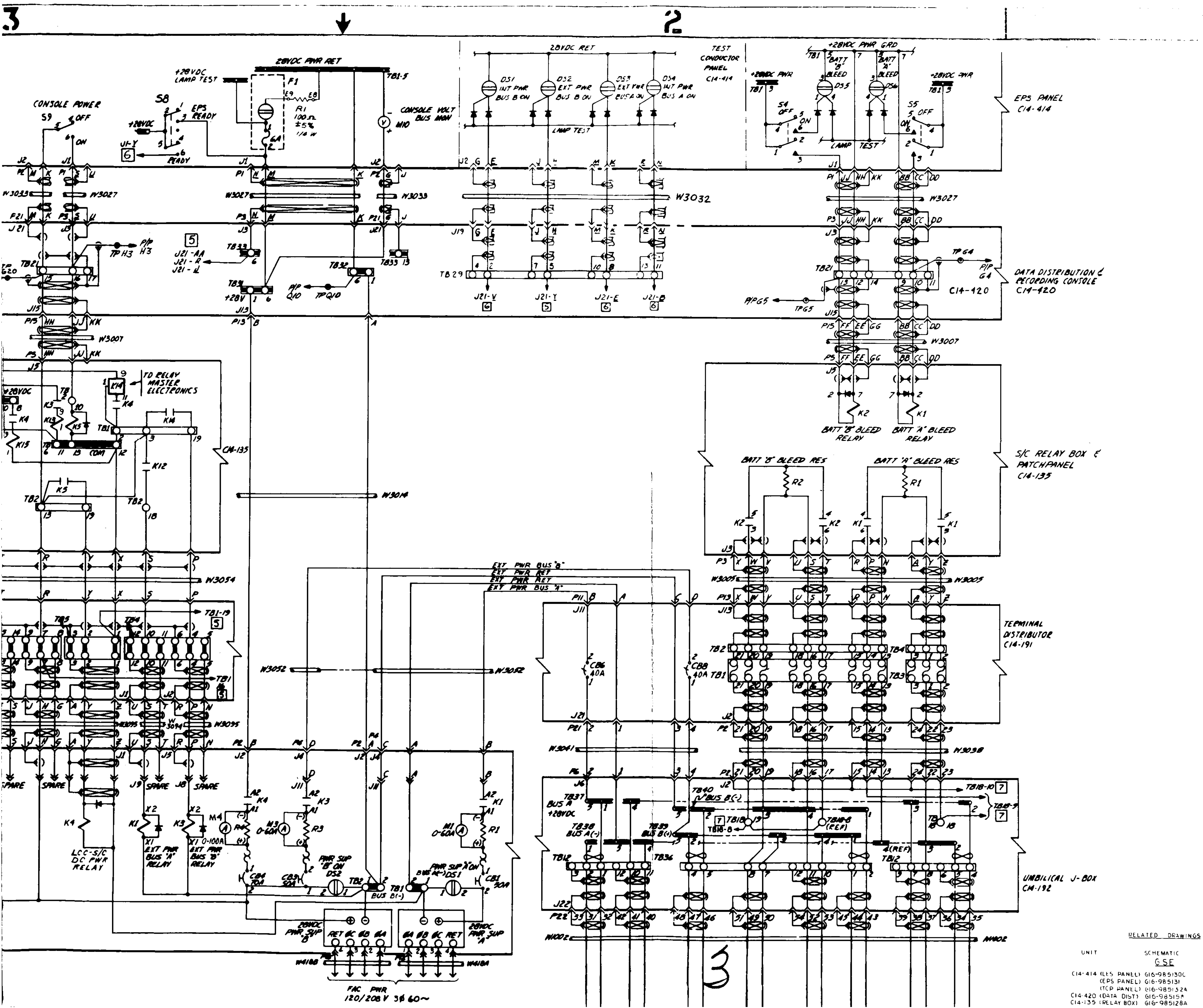
Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 7 of 8)

6



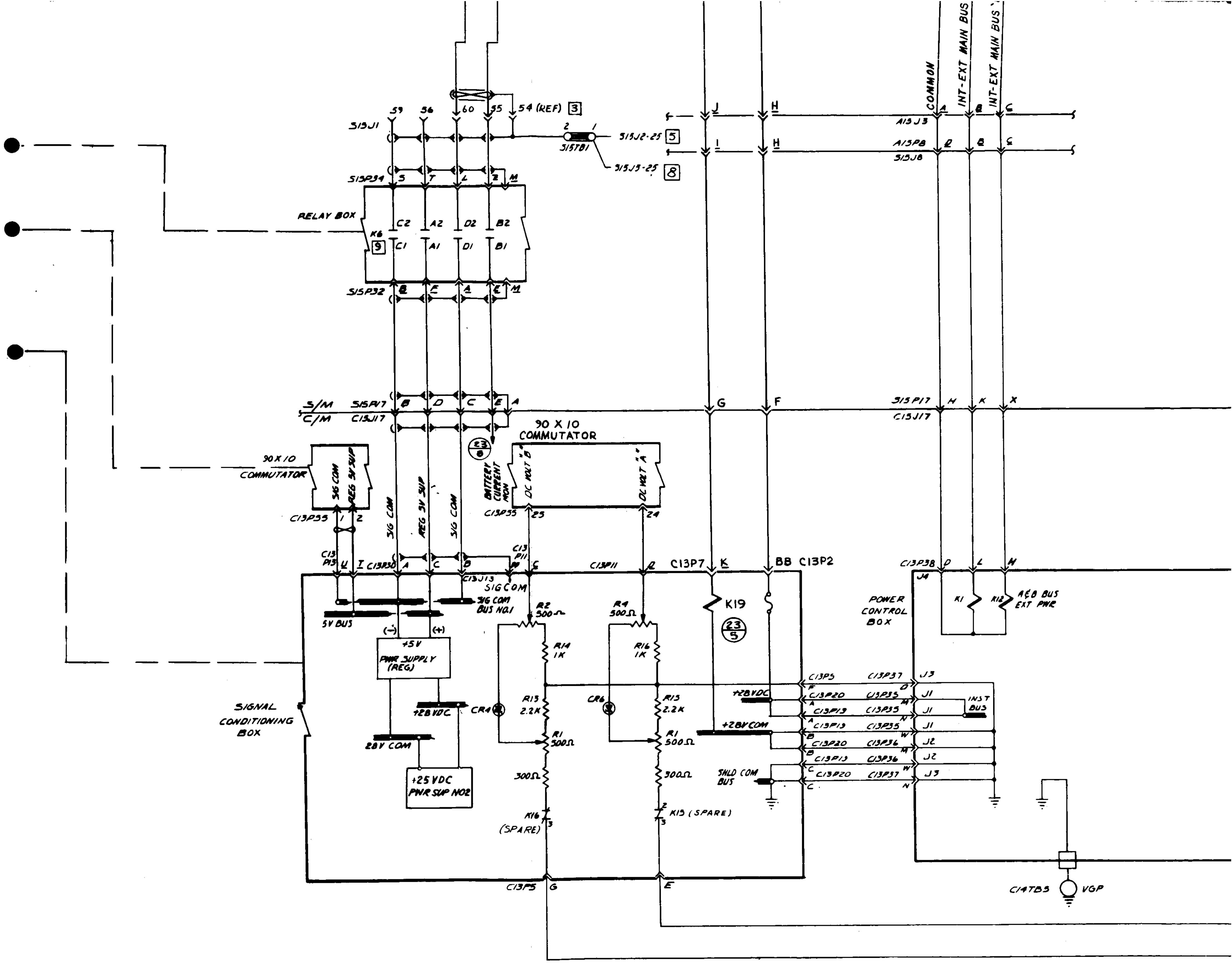
6
5
EPS PANEL C14-414
BATT CURRENT MON
DATA DIST CONSOLE C14-420
S/C RELAY & PATCH PANEL C14-135
TERMINAL DISTRIBUTOR BOX C14-191
UMBILICAL J-BOX C14-132
LAUNCH VEHICLE SUB-UNIT A14-021
S/C GSE CROSSOVER DISTRIBUTOR A14-076
SI LIFT OFF S3
28V RET
LAMP TEST
EPS READY
INT PWR BUS A ON
INT PWR BUS B ON
EXT PWR BUS 'A' ON
DS2 EXT PWR BUS B ON
+28VDC
W3027
W3033
W3008
W3007
W3006
W3034
W3037
W3050
W3074
W1001
CHASSIS GRD BUS
LOGIC RET BUS TB1-1 THRU TB1-20
-12V BUS TB2-4 THRU TB2-6
+12V BUS TB2-1 THRU TB2-3
EXT PWR BUS "B" RELAY
EXT PWR BUS "A" RELAY
P/P-P14
P/P-G1
P/P-H4
'A' CONT
'B' CONT


4
28VDC RET
INST BUS ON
DS7
DS8
DEAD FACE RELAY
TB1
LAMP TEST
S6
S7
CHASSIS GRD
BUS "A" MON
BUS "B" MON
BUS "A" PWR XFER
BUS "B" PWR XFER
BATT 'B' BLEED MON
BATT 'A' BLEED MON
DS15 UMBILICAL CONNECT
+28VDC LAMPTEST
K5
K5 UMB CONNECT
+28VDC
TEST CONDUCTOR PANEL C14-414
S2-9
W3033
W3027
W3032
W3031
W3007
W3008
W3005
W3006
W3020
W3017
W3054
TB3 PWR SHLD BUS
TB32 VDC RET
TB31 +28VDC PWR
TD RELAY MASTER ELECTRONICS
F1 MSC PWR READY
+28VDC LAMP TEST
MSC PWR
28VDC RET
MSFC PATCH & LOGIC DIST SUB UNIT NO.1 A14-075
TERMINAL DISTRIBUTOR BOX C14-131
GSE CROSSOVER DISTRIBUTER AM-076
UMBILICAL "J" BOX CM-132
W3039
W3040
W3038
W3037
W1002
W1001
LIFT OFF IND
LIFT OFF PWR
SENSING P/S "A"
SENSING P/S "B"
PWR SUP CONSOLE CM-418
(-) HOLDING
(-) RET
2

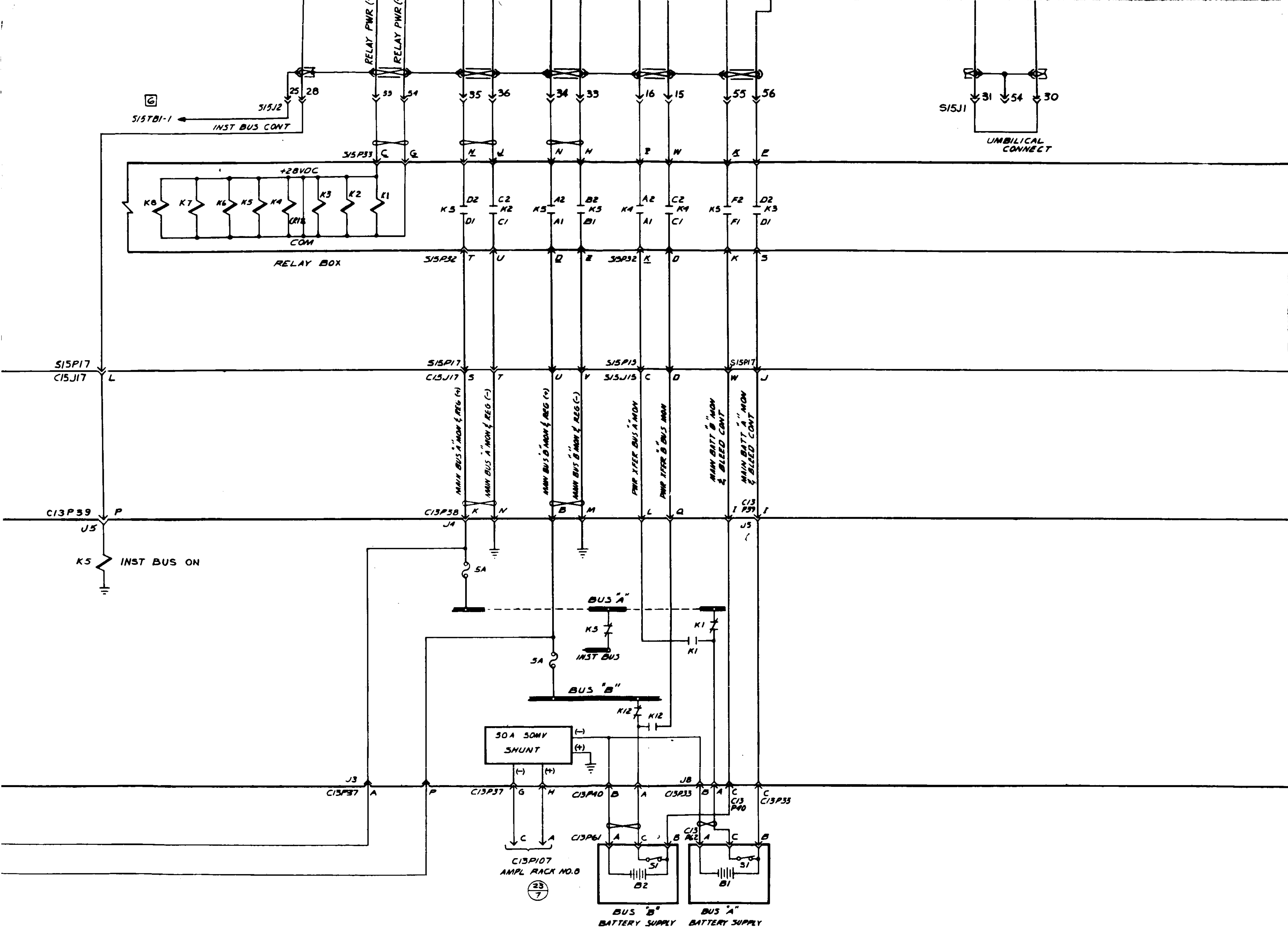


RELATED DRAWINGS

UNIT	SCHEMATIC GSE	WIRING DIAGRAM
C14-414 (LES PANEL)	G16-985130C	G16-853983B
(EPS PANEL)	G16-985131	G16-653993A
(TCP PANEL)	G16-985132A	G16-853953A
C14-420 (DATA DIST)	G16-98515A	G16-850533
C14-135 (RELAY BOX)	G16-985128A	G16-852563

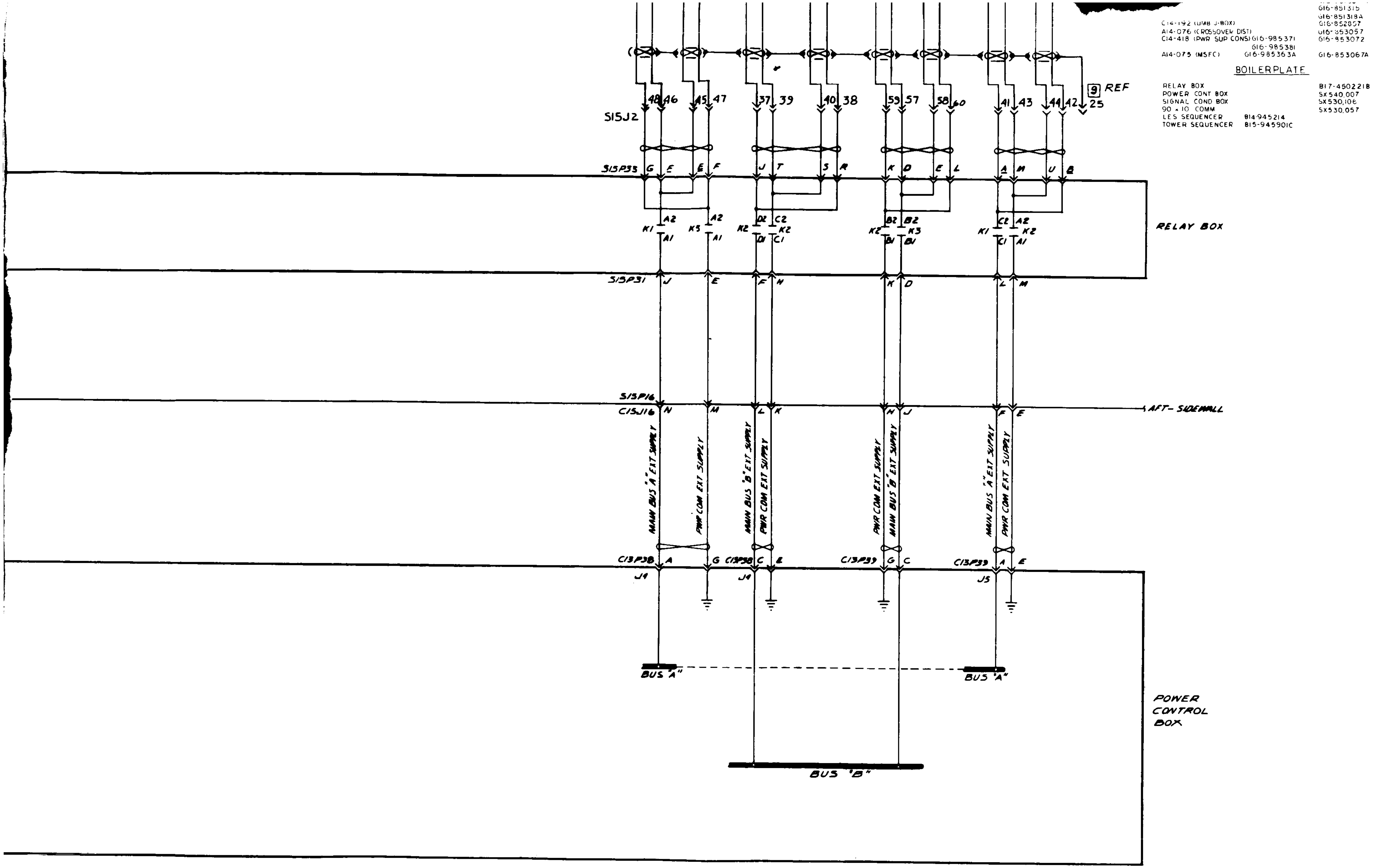

COMMON
INT-EXT MAIN BUS
54 (REF)
RELAY BOX
S/M
C/M
90 X 10
COMMUTATOR
BATTERY CURRENT MON
DC VOLT "B"
DC VOLT "A"
SIG COM
REG 5V SUP
5V BUS
SIG COM BUS NO.1
+5V
PWR SUPPLY (REG)
+28VDC
28V COM
+25VDC
PWR SUP NO2
SIGNAL CONDITIONING BOX
K19
POWER CONTROL BOX
A&B BUS EXT PWR
INST BUS
+28V COM
SHLD COM BUS
K16 (SPARE)
K15 (SPARE)
C14TB5
VGP

4



RELAY PWR
RELAY PWR
S15J2
S15TB1-1
INST BUS CONT
S15P33
+28VDC
K8 K7 K6 K5 K4 K3 K2 K1
CR18
COM
RELAY BOX
S15P32
S15P32
S15J1
UMBILICAL CONNECT
S15P17
C15J17
S15P17
C15J17
S15P15
S15J15
S15P17
MAIN BUS "A" MON & REG (+)
MAIN BUS "A" MON & REG (-)
MAIN BUS "B" MON & REG (+)
MAIN BUS "B" MON & REG (-)
PWR XFER BUS "A" MON
PWR XFER "B" BUS MON
MAIN BATT "B" MON & BLEED CONT
MAIN BATT "A" MON & BLEED CONT
C13P39
C13P38
J5
J4
J5
K5 INST BUS ON
5A
BUS "A"
INST BUS
5A
BUS "B"
K12
50A 50MV SHUNT
J3
C13P37
C13P37
C13P40
J8
C13P33
C13P33
C13P61
C13P107
AMPL RACK NO.8
23
7
S1
B2
S1
B1
BUS "B" BATTERY SUPPLY
BUS "A" BATTERY SUPPLY

5



SM-2A-571

Figure 8-1. Boilerplate 15 and GSE Hangar Checkout Equipment Combined Systems Schematic (Sheet 8 of 8)

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